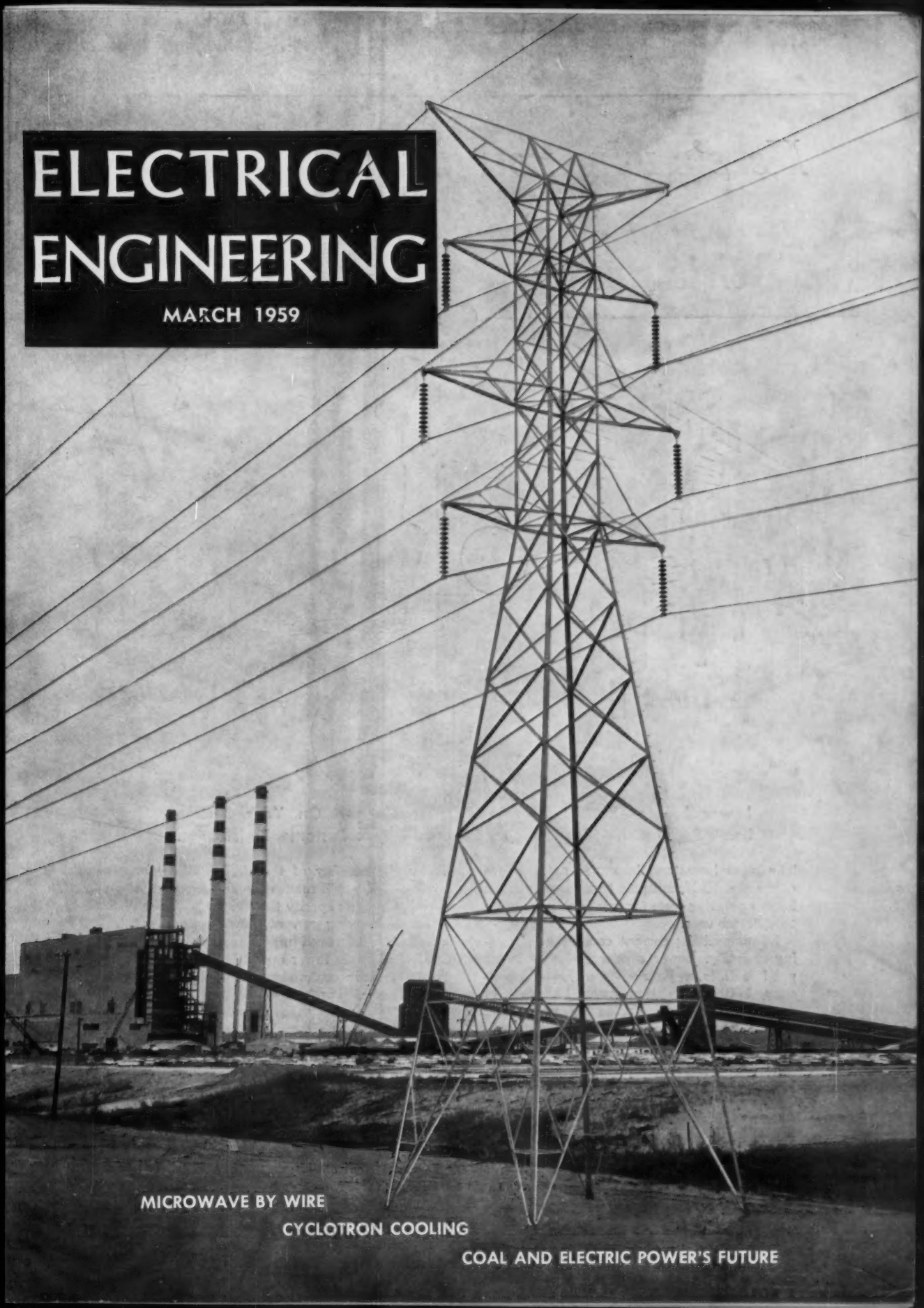
ELECTRICAL ENGINEERING

MARCH 1959



MICROWAVE BY WIRE

CYCLOTRON COOLING

COAL AND ELECTRIC POWER'S FUTURE

Here's why you get more for your transformer dollar this year . . .

Lower Losses—Put Less Drain Per Transformer On Your System
Better Regulation—Means Higher Revenue—More Customer Satisfaction

The lower losses and improved performance of the new Kuhlman pole transformers mean lower operating costs for you from generation to ultimate user.

Lower exciting current conserves generating capacity. Lower copper and core losses put less drain on your system. Lower impedance, better regulation mean less loss of power and revenue during heavy loading hours. Take even an average 10% improvement in the above performance and multiply it by the number of transformers in your system and you'll realize the savings that is yours when you specify the *all new* Kuhlman.

Lower exciting current, lower copper and core losses, improved impedance, better regulation, all mean lower operating costs, more revenue, more customer satisfaction. If you have been waiting for the best time to buy—buy now. And buy Kuhlman. There never will be a time when you'll get more for your transformer dollar.

KUHLMAN ELECTRIC COMPANY
65th year
The year you get more for your transformer dollars

KUHLMAN POLE TYPE TRANSFORMERS

KUHLMAN ELECTRIC COMPANY General Offices: Birmingham, Michigan
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ELECTRICAL ENGINEERING

MARCH 1959
Vol. 78, No. 3

75 Years — A Prologue to the Future

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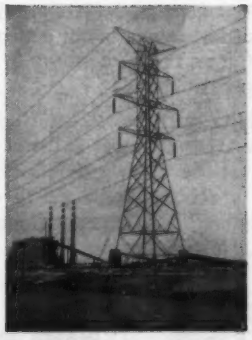

THE COVER: Transmission tower and power plant of the Memphis (Tenn.) Light, Gas and Water Division's Thos. E. Allen Electric Generating Station. Story appears on page 279.

Published monthly by American Institute of Electrical Engineers

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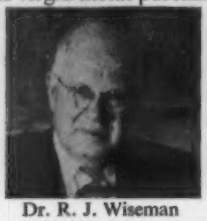
Oxide and Sulfide Impurities can Endanger the Life of a Paper Cable . . .

All lead used for Okonite cable sheaths is virgin metal purchased under ASTM specifications. However, since even the best virgin lead possesses oxide and sulfide impurities, Okonite never uses it for sheathing cables until it has been purified with sodium. This unique process is called "Lead Stabilization."



Dr. R. J. Wiseman
Chief Engineer

There is a very good reason for undertaking this extra process...*under stress, lead tends to fracture at the boundaries of the crystals that make it up.* Therefore, a cable sheath composed of lead crystals that are surrounded by oxides and sulfides is not as strong as one that is free of this foreign matter. By eliminating these oxides and sulfides through "Stabilization," a rearrangement of the metal's crystal structure can take place. Consequently, the individual crystals are no longer isolated by the impurities that normally concentrate at their boundaries. With the weak spots between the crystals eliminated, the metal can form itself into a strong, homogeneous material. The accompanying photo-micrographs illustrate this point.

* * *

Stabilization makes two other significant contributions to the long life of Okonite Paper Cable Sheaths. *First*, it enables alloying elements to disperse thoroughly and evenly throughout the lead. *Second*, it prevents the formation of oxides during subsequent sheath foundry operations. Consequently, uneven alloy distribution and weak, "impurity-loaded" sheaths are effectively eliminated.

ASTM Lead

Stabilized Lead

. . . what the microscope reveals

Mixing Sheath Alloys Prior to their Use at the Lead Press is Important

Stabilized Lead is the basic metal from which Okonite compounds all its various sheath alloys. The "Stabilizing" process is composed of 4 steps: (1) melting the virgin lead, (2) treating it with sodium, (3) removing the released impurities, and (4) recasting it into ingots. Okonite prepares the more complicated alloys immediately after Step 3. In other words, *all Okonite alloys are mixed prior to their use at the lead press.* They are fed into the press in the form of finished alloy ingots, ingots in which every ingredient is thoroughly and evenly distributed. Pre-mixing assures an absolutely uniform alloy, one that provides equal protection throughout the entire length of the cable sheath. In addition, recasting the alloys prior to their use at the lead press provides us with an opportunity for quality control testing of each batch.

1. Stabilized Lead and

2. pre-mix of alloys . . .

. . . two concrete instances of the *added values* in Okonite paper cables.

. . . giving lead the sodium treatment

Today, every good engineer I know is seeking ways to get the maximum value out of the money he invests for his company or client. The *added values* in Okonite paper cables provide an opportunity to get extra life and dependability out of electrical cable systems. As one engineer to another, I urge you to become better acquainted with the long range economy of Okonite paper cables.

If you have not received your copy of the new Okonite paper cable catalog, or if I can be of help to you with a current problem, please get in touch with me at The Okonite Company, Passaic, New Jersey.

6060

***where there's electrical power . . . there's* OKONITE CABLE**

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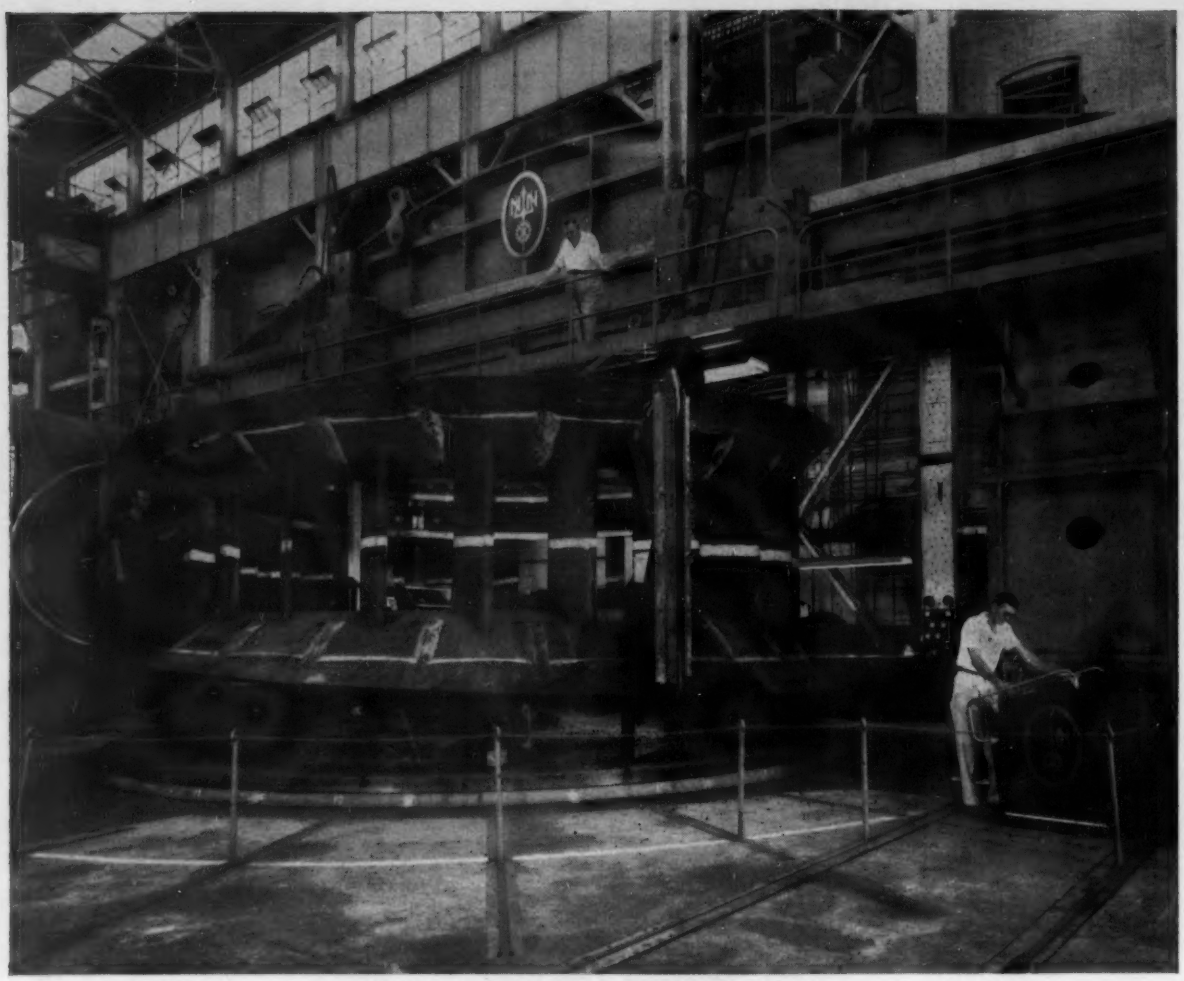

42 ft. boring mill-rough cuts a stay ring for one of the world's most powerful hydraulic turbines.

Newport News builds six king-size turbines for Niagara Power Project

These skilled Newport News machinists are milling a stay ring for one of six 200,000 hp. Francis-type hydraulic turbines. Before they're finished, they'll turn out five more turbines—the world's most powerful—for the Lewiston Power Plant of the Niagara Project.

Newport News has not only the men, but the facilities to take a job like this in its stride . . . your job, too. For example, the 42 ft. boring mill pictured above was designed and built at Newport News.

The large engineering and technical staffs, acres of iron, brass and steel foundries, five huge machine shops, and additional specialized equipment make Newport News a leader in the production of hydraulic turbines, valves, gates, penstocks, and other water power equipment you need.

Consult Newport News engineers on preliminary design recommendations at no obligation.

Engineers . . . Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

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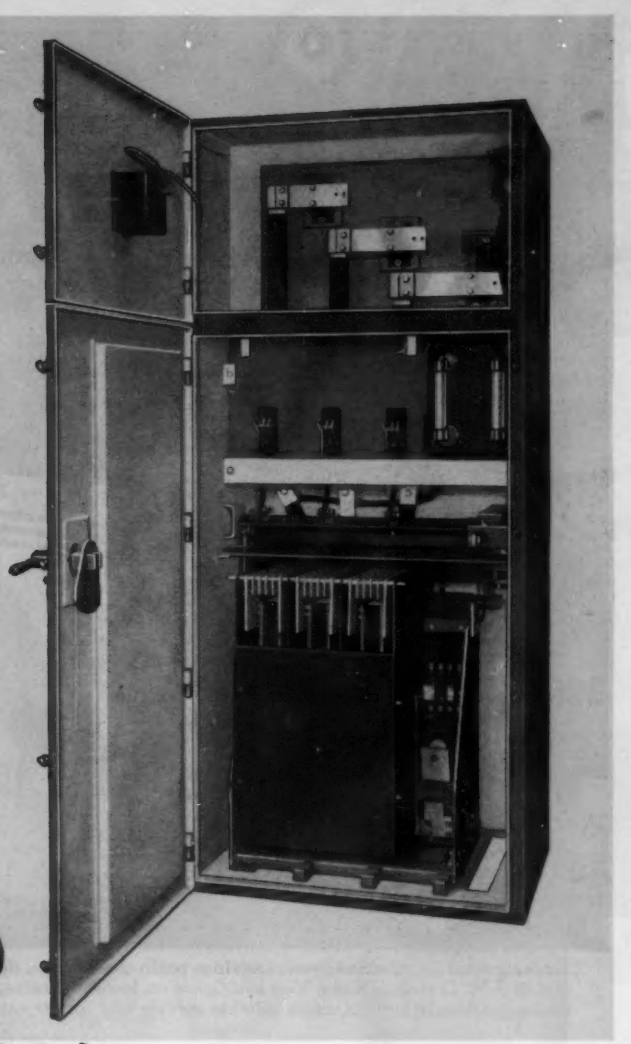
NEW EC&M STARTER

GIVES

100/150 MVA fault protection



WITHOUT

FUSES!

Proven by tests conducted by an independent testing station, EC&M's new "fuseless" ZHA air-break starter has a certified interrupting capacity of 100,000 KVA at 2400 volts, 150,000 KVA at 4800 volts. This starter is simpler and much more accessible for inspection and checking connections.

The ZHA starter is not subject to problems associated with fuses. Single phasing due to blown fuses is eliminated...no costly replacement fuses to stock.

For positive personnel safety, the ZHA is equipped with a 3-way doorlatch, interlocked between disconnect switch and contactor interlocking system. The disconnect switch is gang-operated. When the door is open, disconnect blades are *visible* in the open and grounded position.

No roll-out needed...phase barrier and arc-chutes draw out horizontally, making front and rear contact tips readily accessible. Bus bars are used for power connections throughout the starter. Redesigned arc-chutes and interphase barrier, and improved contactor are additional features which make the ZHA starter your logical choice for high-voltage motor drives.

***GET THE COMPLETE STORY** on certified fuseless fault protection for high-voltage motor drives. Write for Bulletin 8130*

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

2320

Underground distribution system savings begin the day you decide to install J-M Transite Ducts. You can figure on lower operating costs, prolonged insulation life, more reliable service and longer cable life.

J-M Transite Ducts permanently resist fire and arc... provide lifelong dependability, many operating economies

GONE ARE MANY of the headaches of transmitting heavy electrical loads underground, when you protect cables with Johns-Manville Transite® Ducts. They assure you of greatest protective value, and maximum load capacity, per dollar invested.

And when cable fire or failure occurs, noncombustible Transite Ducts remain undamaged and can be used again for the new lines. Regardless of conditions, Transite Ducts provide permanent service as they do not deteriorate from heat, water or corrosive soils.

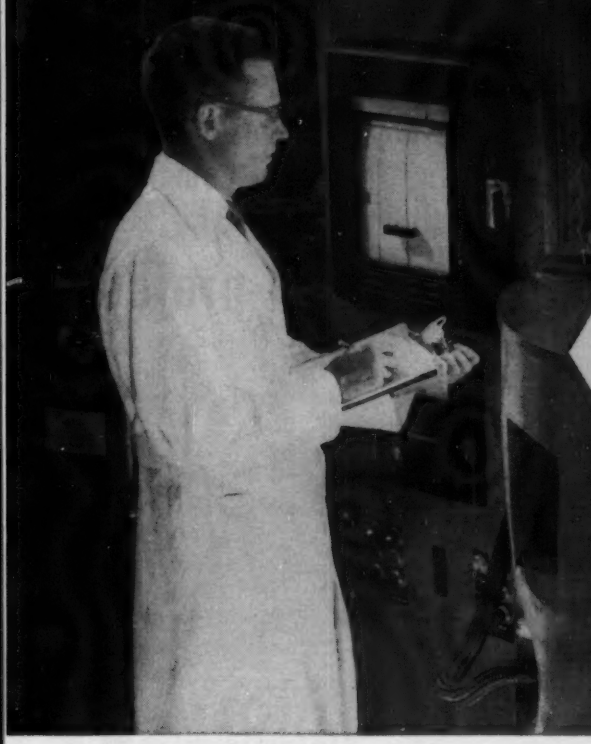
Tests have shown that Transite-protected cables run cooler under given loads . . . carry greater loads at given temperatures because Transite helps dissipate heat faster. And for lower operating costs, consider the long-range value of Transite Ducts in terms of (1) increased insulation life, (2) fewer cable failures, and (3) lower I^2R losses for the full working life of a system.

For details on Transite Ducts' many advantages, distribution engineers are invited to write for informative brochure EL-29A. Johns-Manville, Box 14, New York 16, N.Y. In Canada, 565 Lakeshore Road East, Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

VAREX® has less moisture!



New drying technique results in low watts loss, and long life expectancy

A combination of two drying methods is used to remove moisture from the inside of a capacitor prior to impregnation with askarel.

1 - - *High temperature.* This part of the combination is limited since above 135 degrees C. the heat will deteriorate the insulating paper.

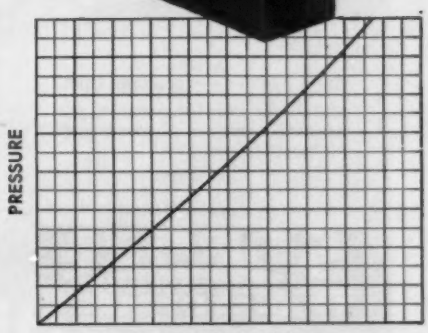
2 - - *High vacuum.* Here the only limitation is the effectiveness of the pumping equipment and the arrangement for coupling it to the capacitor.

O-B has developed a low absolute pressure (high vacuum) drying system for Varex that removes the maximum amount of moisture. This is not just a claim; it can be definitely measured.

Why is this significant to you? The almost complete lack of moisture is reflected in a low power factor for Varex units. Watts loss per KVAR is low, so that less heat is generated in the insulation than in capacitors with higher moisture content.

With less heat, the capacitor insulation lasts longer. And that's why you can expect long life and top performance when cool Varex capacitors are installed on your lines.

OHIO BRASS COMPANY, MANSFIELD, OHIO



For a given temperature, the lower the drying pressure the more moisture is removed. Drying pressure for Varex is on the order of 15 microns.

Ohio Brass

HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

4848-H

Sorgel dry-type transformers are most practical

SORGEL dry-type transformers can be installed at load centers, without fire-proof vaults, using higher voltage feeders, requiring smaller copper, increasing efficiency, improving voltage regulation, and reducing wiring costs.

COST LESS TO INSTALL, because they are all self-contained in a single unit — either single phase or 3-phase — equipped with substantial wall brackets or floor mounting base. No separate brackets to make or buy. Easily accessible, roomy connection compartment. Solderless terminals.

QUIETEST OPERATION. All Sorgel dry-type transformers are so quiet that they can be installed in any convenient place, close to load centers, in institutional, commercial and industrial buildings, thus assuring the most efficient distribution, best voltage regulation, and lowest wiring cost.

TYPICAL APPLICATIONS. Operate 120 volt lighting and portable equipment from 240, 480, or 600 volt power circuits.

For high voltage interior distribution systems of 2400, 4160, 4800, 7200, 13,200 and up to 15,000 volts.

to step down the higher distribution voltage to utilization voltage at load centers, in institutional, commercial, and industrial buildings, and

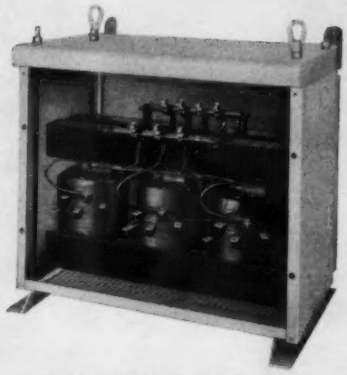
modernization projects

Complete line
1/4 Kva to 10,000 Kva
120 to 15,000 volts

Approved by Underwriters' Laboratories on all ratings covered by the Re-Examination Service, both single phase and 3-phase

•

Also special transformers and saturable reactors



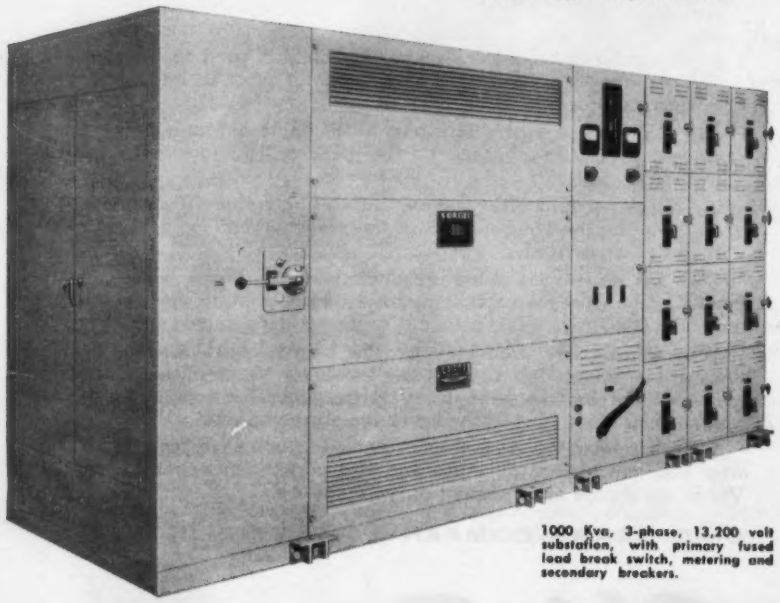
45 Kva 3 phase transformer with taps. Interchangeable wall or floor mounting. Connection compartment panel removed.

Substations

The same quiet SORGEL dry-type or Askarel-cooled transformers, in ALL ratings up to 10,000 Kva and up to 15,000 volts, are also incorporated in substations. Procurable with any type or make of switchgear, and from any substation manufacturer.

Sales engineers in principal cities.

Consult the classified section of your telephone directory or communicate with our factory.



1000 Kva, 3-phase, 13,200 volt substation, with primary fused load break switch, metering and secondary breakers.

SORGEL
SOUND-RATED DRY-TYPE
TRANSFORMERS

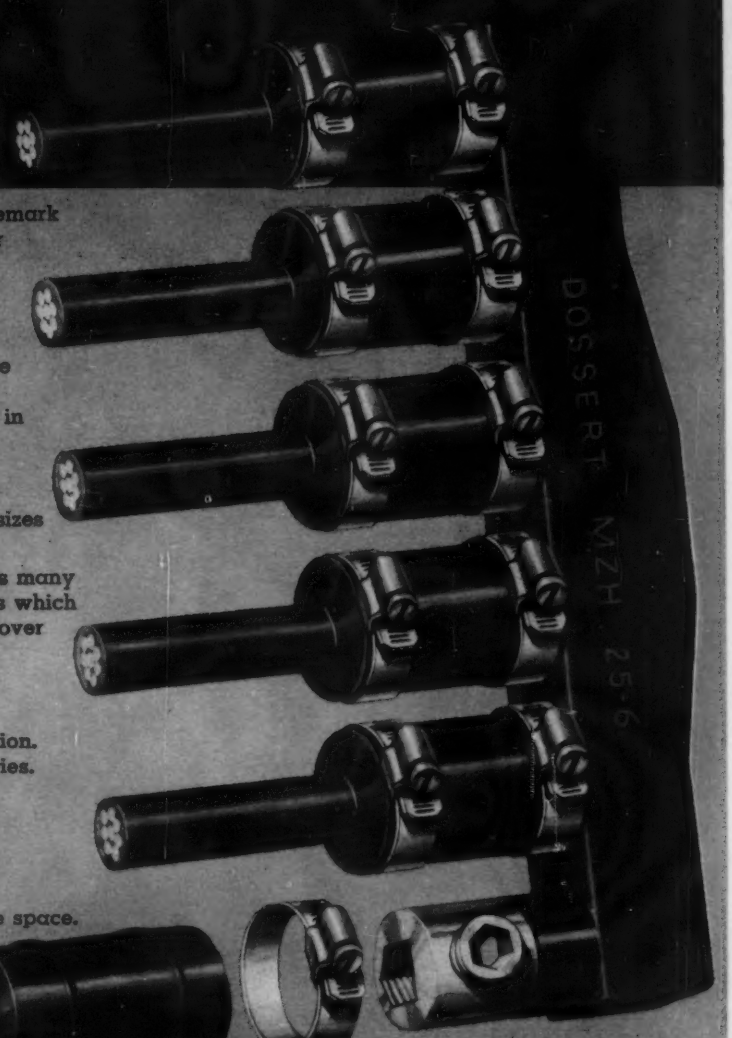
SORGEL ELECTRIC CO., 846 West National Avenue, Milwaukee 4, Wisconsin

Over 40 years' experience in the development, manufacturing and application of transformers

DOSSERT MICON*

(Tapeless Underground Connector)

More COMPACT
More RELIABLE
LOWER in COST

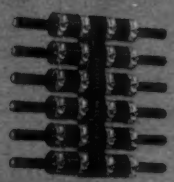


MICON is a Dossert Mfg. Corp. trademark for a tapeless underground connector especially designed for residential and industrial underground distribution systems. This brand of connector is fully insulated for joining up to 8 electrical cables where watertightness must be insured. MICON tapeless connector is simple in concept and well proven principles have been used in its design. No extra components are needed to accommodate a wide range of cable sizes in any outlet position.

MICON brand tapeless connector has many outstanding features and advantages which constitute a substantial improvement over older style and competitive fittings. The most important ones are:

- Lower cost of complete fitting.
- Less field time required for installation.
- Wide cable range without accessories.
- No plastic parts to crack or chip.
- No extra bushings required to fit different insulations.
- All parts are designed for easy accessibility and easy installation.
- Compact design conserves manhole space.

Dossert MICON brand tapeless Crab-type Connector is especially designed for joining up to 12 electrical cables. This connector is an original Dossert design and adheres to the same principle as the tapeless type. Write for special catalog.



Request also complete UNDERGROUND CATALOG UG 53-1

*Pat. Pend. Reg. Trade Mark applied for

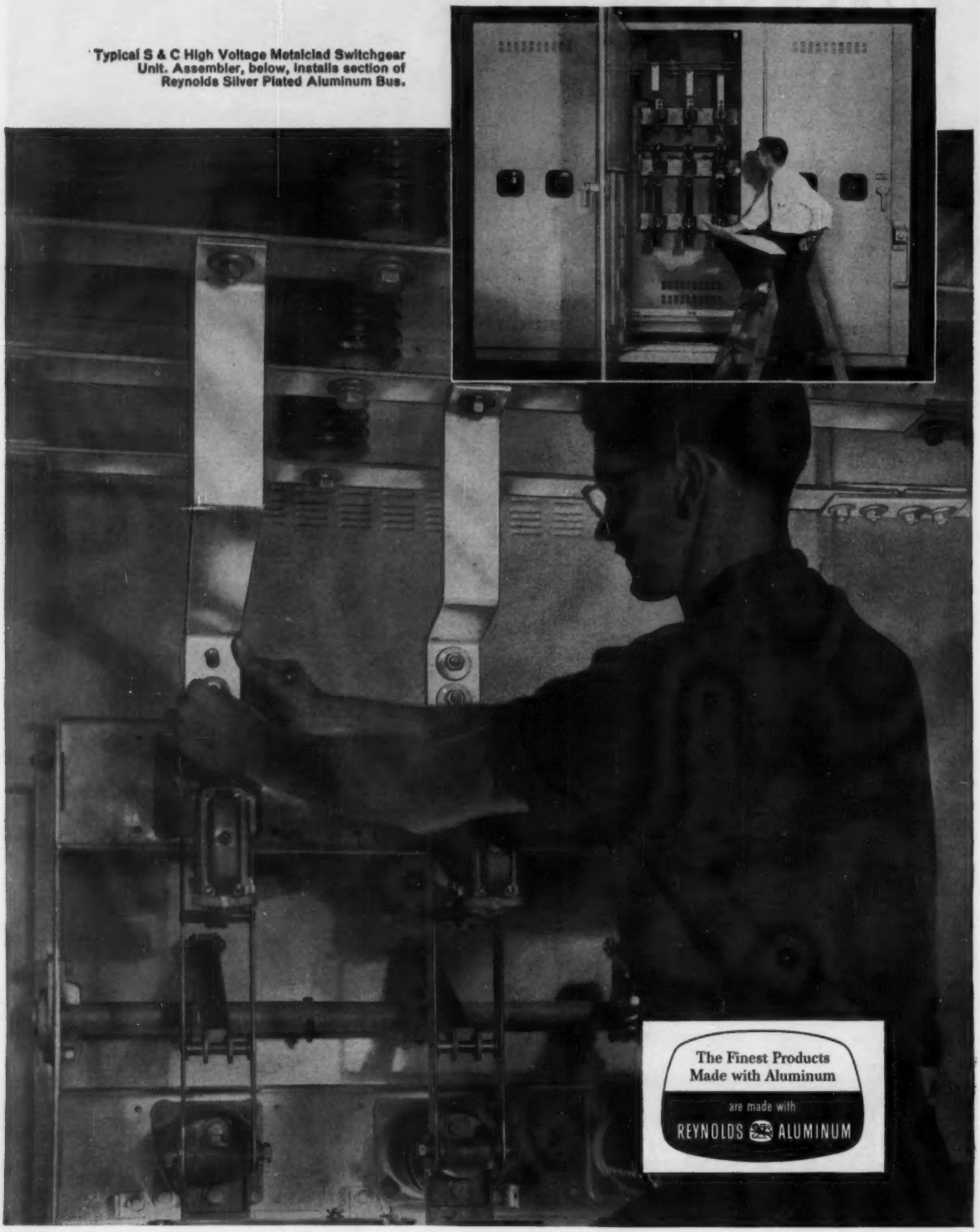
50

DOSSERT MFG. CORP.

249 Huron Street, Brooklyn, New York

S&C metalclad switchgear

Typical S & C High Voltage Metalclad Switchgear Unit. Assembler, below, installs section of Reynolds Silver Plated Aluminum Bus.



production runs smoother with REYNOLDS ALUMINUM Silver Plated Bus Bar

Design and Appearance Improved . . . Forming, Sawing, Punching Simplified

S & C Electric Company, Chicago, Illinois, finds Reynolds Silver Plated Aluminum Bus Bar ends bothersome and costly production problems . . . and provides extra plus benefits too!

First, Reynolds Silver Plated Bus Bar needs no preparation, painting or masking before fabrication. The bar is simply taken from stock and put right into production.

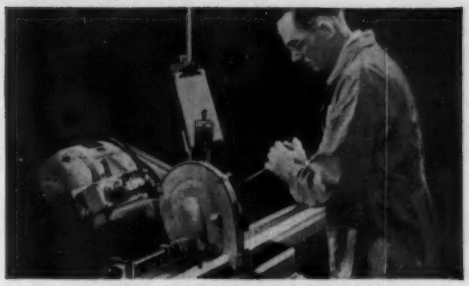
Second, aluminum is exceptionally easy to fabricate. And, the silver plating . . . designed and quality controlled by Reynolds . . . never peels or chips around the work edges in punching, forming or sawing.

Reynolds Silver Plated Bus Bar contributes to the attractive appearance of S & C metalclad switchgear available for both indoor and outdoor high voltage applications. And, S & C obtained all these advantages without changing from previous enclosure size standards.

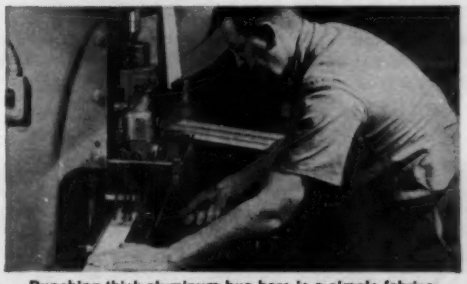
Lower in cost than equivalent copper bar, Reynolds Silver Plated Aluminum Bus Bar requires no prior preparations, provides simple, inexpensive and reliable connections. It's the first commercially available plated aluminum bar with established quality standards! It meets *all* electrical code requirements.

These are just a few of the reasons why aluminum is being used more and more in modern electrical distribution systems.

For details and availability data, write today for the new brochure, "Reynolds Silver Plated Aluminum Bus Conductors", *Reynolds Metals Company, P. O. Box 2346-ER, Richmond 18, Virginia.* For assistance from Reynolds Engineering Service call your nearest Reynolds office or write to the above address.



Reynolds Silver Plated Aluminum Bus Bar is easily sawed, yet the plating never peels or chips.



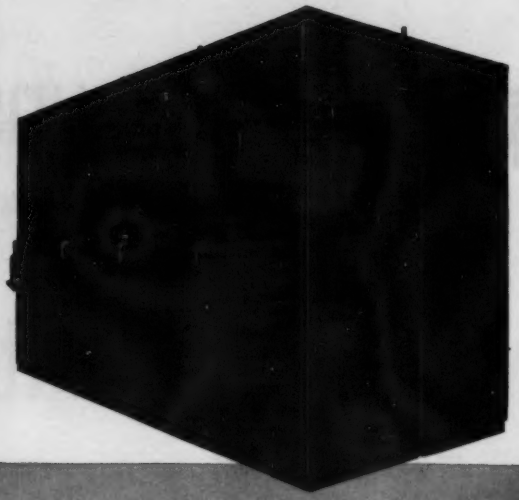
Punching thick aluminum bus bars is a simple fabrication job—and the plating remains in perfect condition.

Silver Plated Aluminum Bus Bar is readily formed on existing equipment.

REYNOLDS ALUMINUM

Watch Reynolds new TV shows—"WALT DISNEY PRESENTS" and "ALL-STAR GOLF"—every week on ABC-TV.

for high voltage service continuity on your critical loads at lower capital outlay— it's S&C Metalclad Switchgear!

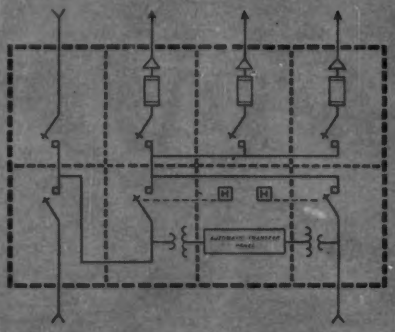


To get service continuity on critical loads, you need preferred-to-emergency switching of your alternate incoming high-voltage supply circuits, and short-circuit protection and switching on your outgoing high-voltage supply feeders. All of this can be provided in one low-cost package in S&C Metalclad Switchgear, as illustrated.

You even have built-in choices of throwover schemes through S&C's standard automatic transfer panels.

You save two ways:

1. You get metalclad switchgear with job-matched load interrupters and power fuses, in lieu of costly circuit breakers.
2. You eliminate cost of custom designing by using an off-the-shelf transfer panel with built-in options.

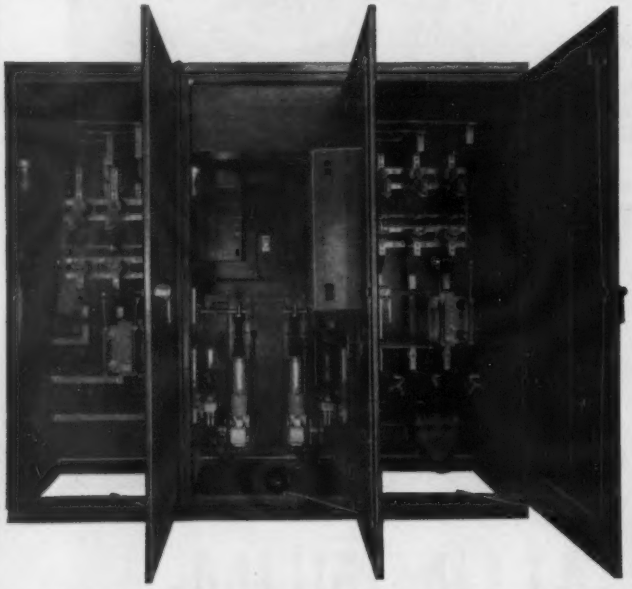


Schematic for 8-bay switching center unit (above) shows throwover control of 2 of 3 alternative incoming sources to provide continuous service for three outgoing feeders.

No organic insulation to cause corona trouble; porcelain and air only.

High-Speed Automatic Switching.

Full-length bulkhead doors; rainproof, with complete access.



Super Durabake finish with galvanized and stainless steel hardware; withstands corrosive atmospheres.

Separate compartment for Moto-Draulic operators; free access and decoupling for checkout.

Strip heaters with adequate venting prevents moisture accumulation.

S&C Standard Automatic Transfer Panel provides for making either source preferred, for automatic or manual return, for adjustable time delays, for choice of returning in either open or closed transition, and for optional lockout on bus faults.

Power Fuses
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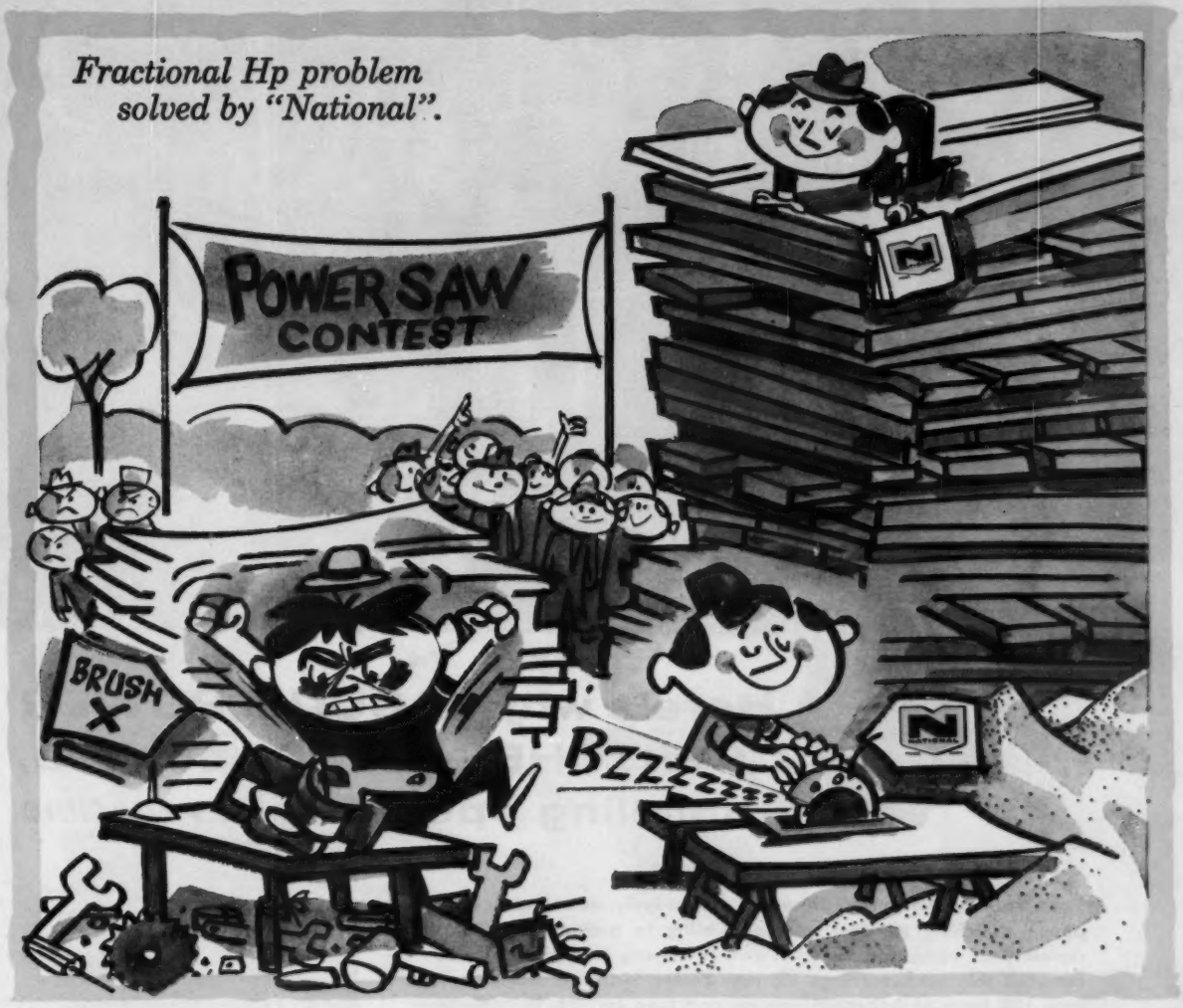

80% longer brush life in this firm's power tools...

THANKS TO NATIONAL TRADE-MARK

LOUIS J. ESPOSITO

This major power tool manufacturer was troubled by short brush life in one of his hand saw models, says "National" Carbon Brush Man Louis J. Esposito.

Performance tests showed excessive sparking, bar burning and uneven brush wear. Lou brought the problem to NATIONAL CARBON'S technical service department. Suggested remedy: a revised spring design and changeover to "National" Brushes Grade F-38.

Result: even brush wear, no further sparking, up to 80% longer brush life—product quality increased, service problems cut down—all with no extra manufacturing costs.

For details on how *you* can have brush tests conducted on small motors, call your "National" Carbon Brush Man. Or, write: National Carbon Company, 30 East 42nd Street, New York 17, N. Y.

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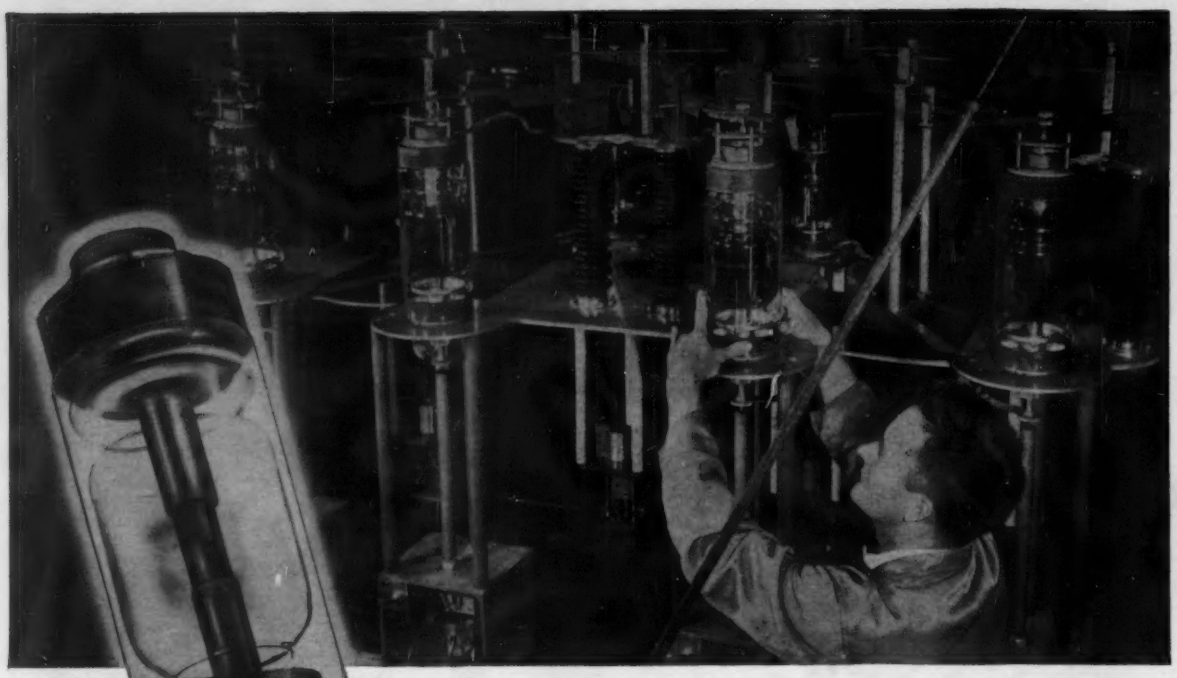

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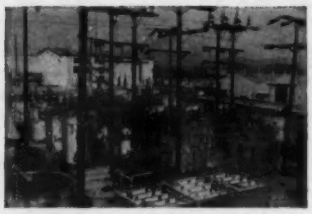
Since vacuum switches represent a distinctively new approach to power switching we feel a responsibility to provide the utmost certainty of operation to each switch leaving our plant. To accomplish this each Jennings Vacuum Power Switch is tested more than 100 times at full rated voltage and load current. In addition, continual life tests are being conducted up to the full capabilities of each switch using capacitive, inductive, and resistive loads.

In order to make these tests possible and to insure perfect operation of every switch, Jennings has gone to unusual lengths to provide more than adequate testing and research facilities.

As an example, Jennings High Voltage Lab has 680,000 kva available with over 6500 amperes at 60 kv for short circuit testing. Up to 2500 short circuit amperes can be developed at 120 kv and surge current tests of 200,000 amperes can be run at low voltage. Since our vacuum power switches are particularly effective in switching capacitors, the equivalent of 20,000 kva of capacitors at voltages up to 230 kv is available for testing. Our vacuum switches can also be tested with 30,000 kva of pure inductive load at voltages up to 115 kv.

Vacuum power switches have inherent advantages that allow them to perform many difficult tasks that cannot be performed by conventional switchgear, but reliability remains its foremost quality. Jennings unusually complete testing facilities and a record of hundreds of successful vacuum switch installations in the power field are your insurance that the vacuum switch is more than capable of performing the function at which it is rated.



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We have prepared literature describing the ten sizes now available for power use. Send for your copy.

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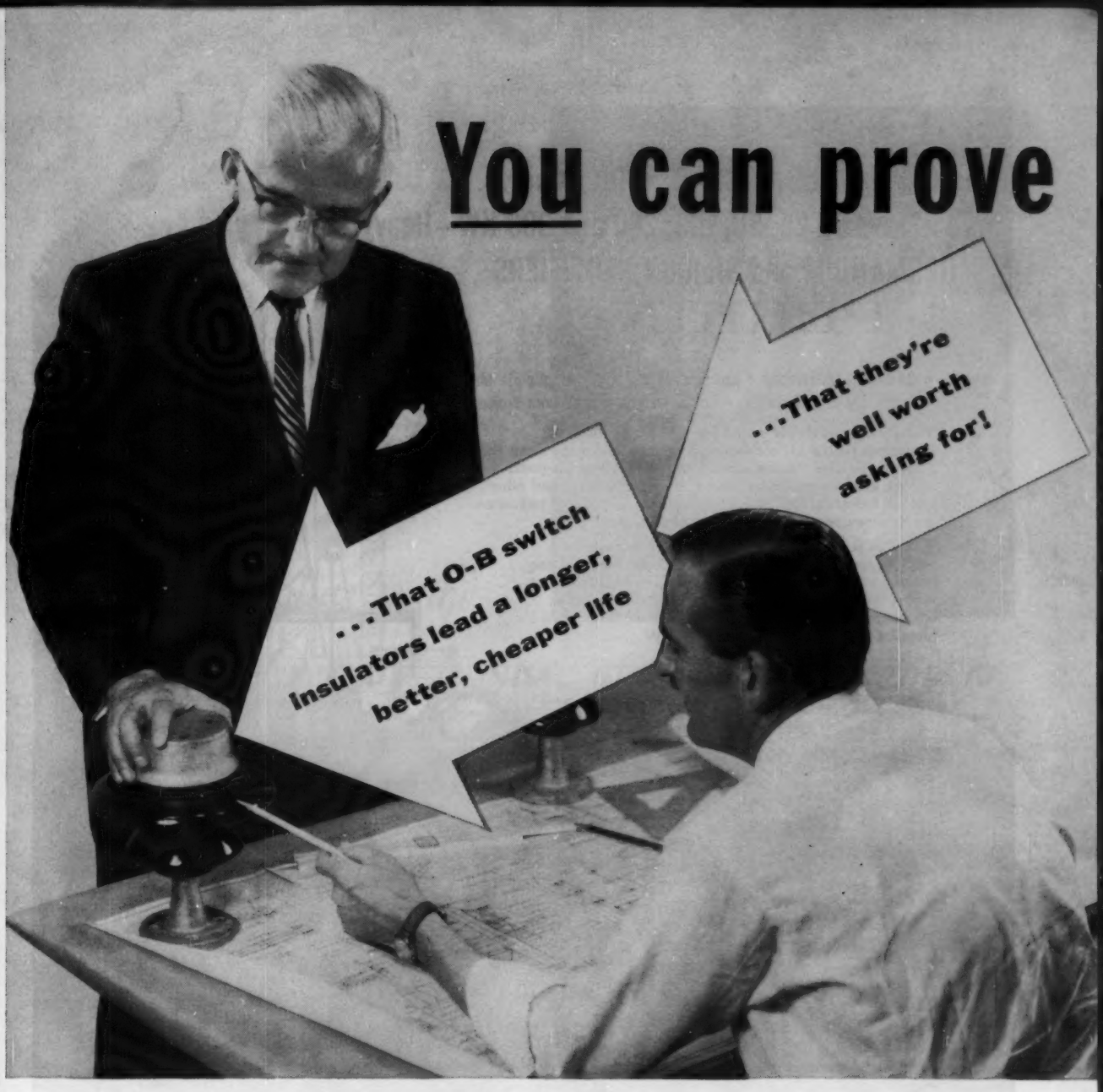

Standards *don't say* all switch insulators are alike -- neither does your experience. Some live longer than others, and give "better mileage" on your investment. Some have a history of little or no trouble; little or no maintenance expense.

Which ones? Look at your own records.

In your own files -- maybe your own handwriting -- and stated in your own terms, are facts that should contain an interesting story. You can see what insulators were installed, when, and the subsequent replacement record, and if your findings are typical, O-B will show a distinct advantage. Remember, this isn't *our* story, it's *yours!*

Switch manufacturers will gladly supply any make of insulator you choose. You need only *make that preference known.* By the simple act of asking for O-B insulators on your new switches, you will continue getting a bonus in performance that your own operating facts can prove is true.

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An IMPORTANT ADVANCE in DC Power...

Standard 25, 50, 100, 200 and 300 KW—Heavy Duty GERMANIUM and SILICON RECTIFIERS

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- 94%-96% Efficiency • Lower cost per KW • Negligible Maintenance
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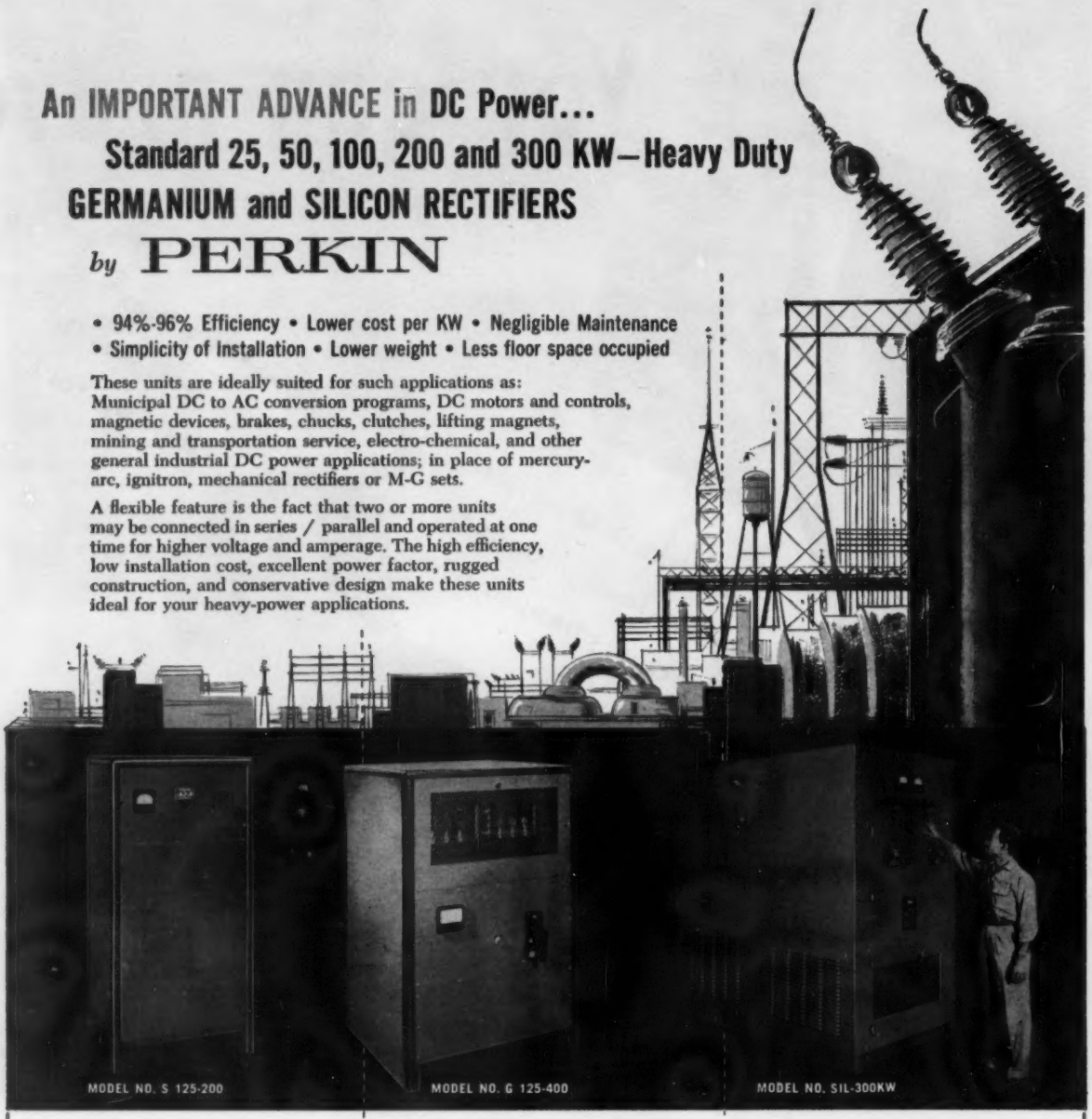
These units are ideally suited for such applications as: Municipal DC to AC conversion programs, DC motors and controls, magnetic devices, brakes, chucks, clutches, lifting magnets, mining and transportation service, electro-chemical, and other general industrial DC power applications; in place of mercury-arc, ignitron, mechanical rectifiers or M-G sets.

A flexible feature is the fact that two or more units may be connected in series / parallel and operated at one time for higher voltage and amperage. The high efficiency, low installation cost, excellent power factor, rugged construction, and conservative design make these units ideal for your heavy-power applications.



MODEL NO. S 125-200 | MODEL NO. G 125-400 | MODEL NO. SIL-300KW

25 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 200/100 amperes
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps (per customer specification)
Voltage Regulation: 5% max.; no load to full load
Ripple: 5% RMS max.
Efficiency: 94%
Duty Cycle: Continuous operation at full load, with ambient temperature of 45°C.

50 KW GERMANIUM RECTIFIER UNIT

DC Output: 115-125 volts @ 400 amps available also connected for 62.5 V @ 800 amperes.
AC Input: 208, 230 or 460 volts, 3 phase, 60 cps
Voltage Regulation: 5%; no load to full load
Ripple: 5% RMS
Efficiency: 94%
Duty Cycle: Continuous

300 KW SILICON RECTIFIER UNIT

DC Output: 125/250 volts @ 1200 amps.
AC Input: 460 volts, 3 phase, 60 cps, (2400 or 4160 V also available—please specify.)
Voltage Regulation: 5%; no load to full load
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100 and 200 KW units, similar in specifications to those above, are also available.

When you require DC power, contact Perkin for a wider range of standard models with prompt delivery schedules. There are over 15,000 Perkin rectifiers in operation in industry today

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A Salute to the American Institute of Electrical Engineers

The transmission of telegraphic signals across the Atlantic Ocean by Marconi in 1901 was a first in communications. The transmission of information from outer space by a solar-powered transmitter aboard Vanguard I in 1958 was another first in communications. Yet neither achievement was a scientific revolution. Instead, each was the inevitable result of an orderly development to which many scientists and engineers had contributed.

In order for this orderly development to take place rapidly, the dissemination of technical information is vital. The American Institute of Electrical Engineers performs this service by carefully screening and publishing technical papers. The professional pride of the individual engineer and his interest in advancing the sciences create a steady flow of carefully prepared technical documents. Furthermore, the encouragement that the AIEE gives student members to write technical papers assures the continuation of this exchange of information.

Many hours of work and tremendous effort have gone into the development of rugged, miniature components, measuring devices, and telemetry systems. The development of semiconductor devices to their present state in 12 years of intense work is phenomenal. Power generation and conversion devices are beginning to receive the attention commensurate with their importance in space exploration.

These are the items which are required to equip a small satellite. These are some of the items which are necessary for manned space flight. These items reached their present state of development through the efforts of electrical engineers and scientists.

On this 75th Anniversary of the AIEE, I congratulate you electrical engineers on your past accomplishments and shall look forward to your continued progress.

Wernher von Braun
Director
Development Operations Division
Army Ballistic Missile Agency

A E E I 75th Anniversary 1884 — 1959

75 Years—
A Prologue to the Future

The Future of Coal and Electric Power

G. R. COREY

A discussion of the direction and rate of growth of electric power based on the experience of the Commonwealth Edison Company. Factors are noted which may greatly affect this direction and rate. The interdependence of the coal and electric industry is emphasized.

THIS IS a discussion of some future plans of Commonwealth Edison Company (CEC), particularly those which will affect the coal industry, and of two important factors which may ultimately change those plans.

First, the conventional facts and forecasts for Commonwealth Edison Company are given.

Coal continues to be CEC's major source of fuel. In 1957, it comprised 85% of the fuel used to operate its 12 generating stations. These stations consumed about 10 million tons of coal in 1957, thus using more coal than was burned by any other electric utility company in the United States except the American Electric Power System.

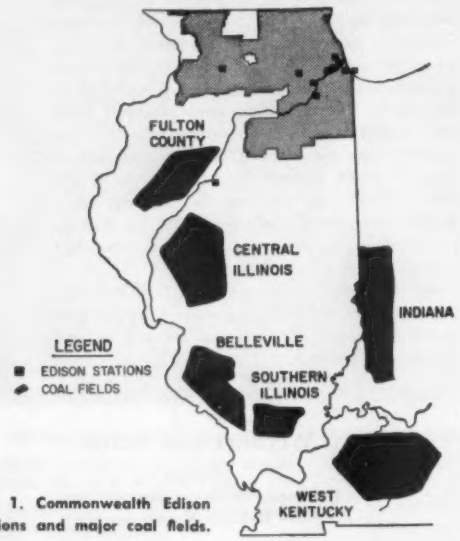

Fig. 1. Commonwealth Edison stations and major coal fields.

Inasmuch as the majority of Commonwealth Edison's generating stations are located near the Illinois waterway, much of its coal is purchased from the central Illinois coal fields (Fig. 1). These fields (including those in Fulton County) are located close to the company's system, where barge delivery up the Illinois River is feasible. Large amounts of coal are also obtained from other Illinois, Indiana, and west Kentucky fields.

Over the past 12 years, since the close of World War II, the company's electric output increased 85%. During the same period, its coal requirements increased 33% (Fig. 2).

During the first part of 1958, the trend of electricity sales was down somewhat because of the general business decline. For example, in the first three quarters of 1958 CEC's kilowatthour sales to industrial customers decreased 7.8% in comparison with the first three quarters of 1957. Taken by itself, this reduction would have reduced the use of fuel by about 250,000 tons. During the same period, however, residential kilowatthour sales were up 5.3% and commercial sales were up 4.1%.

Total kilowatthour sales for 1958 will be about the same as 1957 but fuel consumption will be somewhat lower because several large new generating units have been added which are very efficient. For example, the company's new generating unit no. 3 at Will County Station, which has a capacity of 265,000 kw uses less than 9,200 Btu's to produce one kw-hr (Fig. 3). This compares with the company's 1957 average use of 11,789 Btu's per kilowatthour and with an average use in 1945 of over 14,000 Btu's per kilowatthour.

The improvements in electric generating efficiency are good for both the coal industry and the electric utilities. The one sure way to sell more coal and more electricity is to keep the price of both at the lowest possible level. The coal industry, which has done a remarkable job of improving coal production efficiency, knows that this is true. It is true in the electric industry too. The electrical business is highly competitive. Later on CEC's recent entry into the space heating field will be discussed. Here it is competing directly with oil and gas and it simply has to keep the price of electricity low in order to make any headway.

As a matter of fact, in order for business to continue to grow, Commonwealth Edison must keep electric rates low. Thus, the company is forced to search constantly for cheaper ways in which to produce electricity.

This sort of competition is healthy. And, to the extent that CEC can find such cheaper ways to generate electricity with coal, both the coal and electric industry will benefit.

NUCLEAR FUEL

RECENTLY, HOWEVER, a new source of generating station fuel has entered the competition—namely nuclear fuel. History would seem to indicate that the time eventually will come when nuclear power stations will

A special article recommended for publication by the AIEE Power Generation Committee.

G. R. Corey is vice-president, Commonwealth Edison Company, Chicago, Ill.

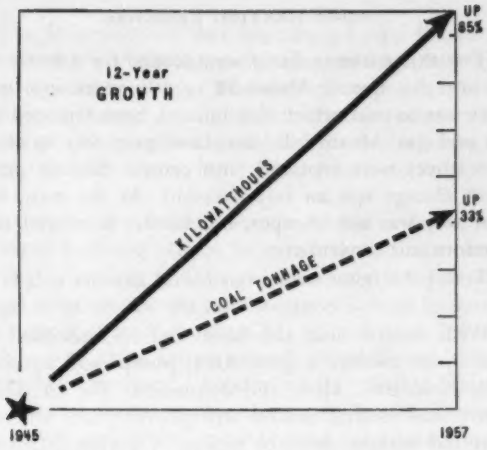

Fig. 2. Growth of electric output and coal requirements over the past 12 years.

supersede coal-fired stations, but when this will occur, if ever, cannot be predicted. Moreover, the continual improvement of coal-fired generation will help to postpone its ultimate arrival.

Now, the prospects for future years. If the remarkably consistent growth trend of the past continues, one would expect electric output to grow at a future rate of 5 or 6% a year. Thus, Commonwealth Edison Company's kilowatthour sales and output should double in another 12 or 15 years. Within the same period, CEC's annual fuel requirements should increase on the order of 5 to 10 million tons.

This assumes that nuclear power will not become economically feasible in the near future and that the future improvements in the efficiency of coal-fired generation will not be as great as the enormous improvements of the past 10 years. These assumptions may be wrong and estimates of future coal requirements may be overstated. No attempt will be made to forecast when, or if, nuclear power will limit the expansion of coal consumption. A few facts may help to evaluate the future of nuclear- and coal-fired generating facilities.

Fig. 4 shows a recent picture of Dresden station—the 180,000 kw nuclear power station located 50 miles southwest of Chicago, which will be placed in service about the middle of 1960. When it is placed in service, Commonwealth Edison expects to have 5 million kw of coal-fired generating capacity. Dresden's capacity will be less than 4% of the total. Furthermore, during the years 1958 through 1961, 1,425,000 kw of coal-fired generating capacity will be added which is eight times the 180,000 kw of nuclear capacity being installed at Dresden. In fact, by the Spring of 1959 CEC will have added 825,000 kw of coal-fired generating capacity since May 1958, capacity capable of burning 2 million tons of coal annually at 60% load factor.

MINE-MOUTH GENERATION

Two important factors which may change future forecasts for Commonwealth Edison, follow:

The first is mine-mouth generation. Mine-mouth generation is not a new idea. Commonwealth Edison's Powerton station, which was built in 1928, is located near the coal mining areas south of Peoria. It was built about 150 miles from the Chicago load center in order to be near the mines.

Today, the construction of mine-mouth stations for CEC is not generally feasible. With present barge rates, the company cannot justify building long transmission lines solely to avoid transporting coal.

However, long-distance electric transmission techniques are improving. In spite of nearly 30 years of inflation, today kilowatthours of electricity can be transmitted at about the same unit cost as in 1929. Meanwhile, freight rates have increased substantially, Furthermore, transmission techniques will probably continue to improve in the future.

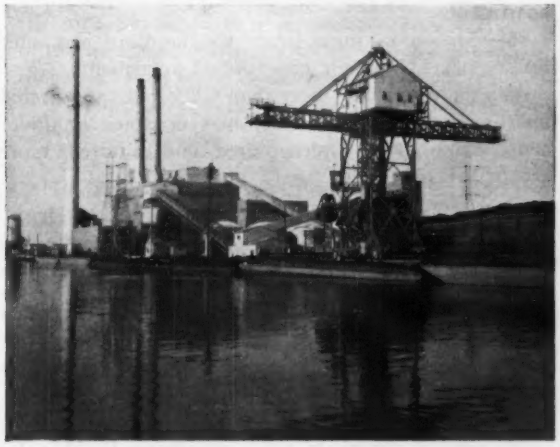

Fig. 3. Generating unit no. 3 at Will County Station.

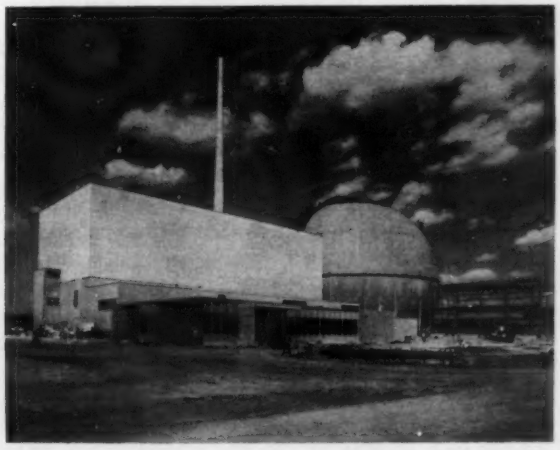

Fig. 4. View of the Dresden nuclear power station.

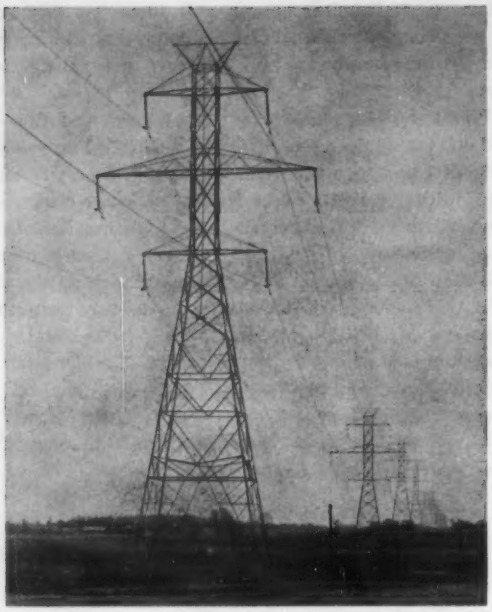

Fig. 5. New 345,000 volt line which connects the Commonwealth Edison System and the American Electric Power System.

Fig. 5 is a picture of the new 345,000-volt line which connects the Commonwealth Edison system and the American Electric Power system. This line was placed in service in May 1958. It represents a major step forward in long-distance transmission efficiency. The 345,000-volt line can carry 500,000 kw continuously.

There are more developments ahead. The engineers are talking of 500,000-volt or even 1 million-volt transmission lines with low line losses. The Soviets are building a 310-mile 800,000-volt transmission line. These developments mean that coal-fired plants located at the mine-mouth, and possibly producing by-product chemicals, may be able to compete successfully with nuclear power plants for many years to come.

ELECTRIC SPACE HEATING

THE SECOND important factor is electric space heating. Some 30 years ago, the average home owner in Chicago used 8 tons of coal a year to heat his house. The domestic market was big business for the coal industry. Since then, oil and gas have taken over. Retail coal sales in the Chicago area have dropped from over 6 million tons in 1927 to about 2 million tons in 1957.

Today, Commonwealth Edison is planning to recapture the residential and commercial heating market for coal, and coal can again become king of the domestic market—coal by wire. This time, though, the electric utility people are partners with the coal people. They will store the coal, shovel the coal, tend the fires, haul the ashes, and even mind the thermostats for the heating customers. Together the coal and electric industries will offer the home owner the cleanest, safest, and most flexible type of heat he can buy—available whenever and wherever he wants it.

HOME HEATING REVIEWED

THE HOME OWNER has always looked for a better way to heat his house. About 50 or 100 years ago, wood gave way to coal, which has, in turn, been replaced with oil and gas. Meanwhile, fireplaces gave way to stoves, and stoves were replaced with central heating plants. Each change was an improvement. At the start, each new way was not cheaper, but better; it offered more comfort and convenience.

Today the home owner has found another still better source of heat—electricity—and the switch is on again.

With electric heat, the flame and its associated dirt and inconvenience is gone. Heat pumps will automatically heat, cool, filter, and dehumidify the air. Direct conversion electric heaters will provide heat wherever required without ducts or piping. A simple thermostat in each room will control the temperature in that room —at whatever level desired—because electricity is converted into heat right where it is wanted. For example, if you wish, you can keep the bedrooms at 60 F, the bathroom at 75 F, and the living room at 70 F. No heat is wasted and there is no bulky central heating plant to operate and maintain. Furthermore, it is "cool" heat. Nowhere in the house is there anything as hot as the bonnet of a conventional furnace which parches the air like a desert.

As with other advances in heating, electric heat is not cheaper but better. Furthermore, its initial cost is low, and it is simple to operate. This applies particularly to the apartment building market. Here, electric heating is better not only for the tenant but for the landlord as well, who is attracted by the investment savings and operating simplicity.

The first and most important item which attracts him is the lower initial cost—from 10% to 50% less than for a conventional heating system.

A second item is lower labor and maintenance cost, because no central operation or control is required.

Third, electric heat does not require space for a boiler room or a chimney, and elimination of this requirement will often provide space for an additional apartment.

In addition to these items, the landlord can offer luxury heated and air conditioned apartments.

As a matter of fact, more than 600 electrically heated apartment dwelling units are now occupied or under construction in the Chicago area, and hundreds more are in the planning stage.

ELECTRIC HEAT COMPARED

COMPARED WITH OIL AND GAS, electric space heating installations have, at the moment, a higher fuel cost. Buildings built today, however, are designed for a relatively long life—from 40 to 50 years. The lower capital cost will stay with the user, but the higher fuel cost may not.

Although we do not expect any major increase in the future price of electricity, many experts predict that the prices of oil and gas will increase at a faster rate in

the next 10 years than they have in the past 10 years. Representatives of the Chase Manhattan Bank in New York City said recently, "The days of surplus gas and cheap gas are over. From here on the consumers will have to pay the increasing costs of producers and explorers . . ." Electricity, however, is relatively inflation resistant.

Since the space heating system within a house or apartment building cannot be switched readily to conform to fluctuating fuel prices, this rising trend of oil and gas prices is very important.

As a result of these factors, CEC believes that electric heat has very great future growth possibilities. It has already been accepted. Approximately 400,000 homes in the United States are now electrically heated. During 1958, 1,300 residential space-heating customers were signed up in the Chicago area, although general business conditions slackened. Furthermore, it has been predicted that by 1965, 1.8 million electrically heated homes may be in use in the United States, 4½ times the present figure of 400,000.

What will this mean to the coal industry? The average electrically heated home in Chicago will use about 16,000 kw-hr of electricity a year for heating—equivalent to 8 tons of coal. But the picture is even brighter—when electric heat is installed, other appliances go electric—cooking, water heating, clothes drying, and air conditioning—adding 6,000 additional kilowatthours to the user's load or 3 additional tons of coal per year. Thus, an all-electric home will, in effect, use 11 additional tons of coal a year—3 tons more than would have been used in the old days to heat such a house with coal.

The market for electric heating is everywhere—offices, stores, factories, and schools. There is a new electrically heated 13-room grade school in Cicero, Ill. Instead of using 21,000 gallons of oil, it will use about 112 tons of "coal by wire" a year. Commercial and industrial electric heating may, in fact, eventually exceed the residential market.

CONCLUSION

ELECTRIC HEATING is going to change the pattern of growth of the electric industry. It will provide the electric business with a large new electric load, and it can provide the coal business with a very large future market for coal. It must be stressed, however, that the only way for the electric utilities to sell more electricity and, hence, to burn more coal is to keep the price of both at the lowest possible level. This means that the highly competitive electric business, if it is to survive and grow—and burn more coal—must constantly strive for greater efficiency.

Report on the Revision of the AIEE Standards Manual

An introduction to standardization activities of the AIEE published to give members and users of the Standards Manual a better appreciation of the steps taken in the development of standards, guides, and test codes as well as ASA procedures.

THIS REPORT is a guide to standardization activities and has been prepared for discussion and subsequent incorporation in the 6th revision of the AIEE Standards Manual.

Division I

I. *The object* of the AIEE, as stated in its constitution, is the advancement of the theory and practice of electrical engineering and of the allied arts and sciences and the maintenance of high professional standing among its members. With this broad scope, AIEE served as the logical place for electrical engineers to meet and discuss their problems, and it was natural that projects in the field of electrical standardization were undertaken in AIEE at an early date.

Beginning in 1890, six years after its founding, AIEE was instrumental in bringing about certain standardization for electrical units, but the broader field of standardization relating to the basis of rating and performance of electrical equipment began in earnest with the appointment of the first AIEE Committee on Standardization in 1898. Subsequently, and at almost yearly intervals, the AIEE standards were published in a single volume, until 1922, at which time a program to expand and publish them as separate pamphlets was begun.

During this period, many other organizations had become engaged in the formulation of standards in

This report has been approved by the AIEE Standards Committee.

electrical engineering as well as other branches of engineering. Often, these standards overlapped or differed in detail and resulted in duplication of work. No one organization was in a position to establish a national authoritative status for its standards. These conditions led to the formation in 1918 by five technical societies, including AIEE, of the American Engineering Standards Committee (which later became the American Standards Association [ASA]) "to unify and simplify the methods of arriving at engineering standards, to secure co-operation between the different societies, and to prevent duplication of work."

Notwithstanding the growing interest of other organizations in electrical standardization, and the complications caused thereby, standardization work has continued to grow and expand as a recognized Institute activity. The AIEE Board of Directors, in 1940, approved a report by President F. M. Farmer which contained the following statement on Institute policy:

> "Standardization in the electrical engineering field is an important element in the advancement of the art—one of the stated objectives of the Institute. Therefore, the Institute should take a prominent and, where appropriate, leading part in all standardization activities with which electrical engineering is concerned."

Regardless of which organization sponsors a standard, the Institute may, through its sessions and conferences, provide a forum for the presentation of reports, papers, and discussions supplying basic information for standards projects in the electrical field.

At the present time, the ASA has a membership of more than 100 national organizations and over 2,000 companies.

The first objective of ASA as stated in its present constitution is:

> "To provide systematic means by which organizations concerned with standardization work may co-operate in establishing American Standards, to the end that duplication of work and the promulgation of conflicting standards may be avoided."

The second objective of ASA is:

> "To stimulate the work of existing committees and other organizations competent to formulate standards suitable for approval as American Standards, and to bring about the establishment of committees or organizations for this purpose where they do not already exist, but not to formulate standards."

Other objectives of ASA include serving as a clearing house for standardization information in this country and abroad, advancement of the standardization movement as a matter of national economy, and serving as an American channel in international standardization activities.

As stated in the second objective of ASA, it is not the purpose of ASA, in itself, to formulate standards. However, the ASA Standards Boards do serve as sponsors for some projects. The chief function of ASA is to provide the procedures by means of which various groups or organizations producing standards in the same or overlapping fields may co-operate in arriving at unified standards which all interested groups can approve and which, therefore, may be truly considered American Standards.

Thus, the activities of the AIEE should be primarily creative in character. The field of its work should be consistent with the objectives of AIEE. Engineers in a professional society can most effectively contribute in the area of basic technical subjects, while many detailed standards can be developed better by other groups. Proposals for the development of standards publications should, therefore, be reviewed with the Standards Committee prior to the initiation of any standards work.

Standards work, after proper review to the extent possible within the framework of the Institute, should result in publications for use or trial use or as proposals for American Standards as the situation indicates. When considered appropriate, AIEE standards publications are submitted to the ASA for review by all other bodies having a substantial interest in them. After approval, with possible modifications, they become American Standards as well as Institute Standards.

II. *Definitions of Terms.* In the material which follows, terms are used in accordance with the following definitions.

AIEE STANDARDS PUBLICATIONS

THIS TERM is used to cover Institute publications pertaining to standards and related material after approval by the Standards Committee.

AIEE STANDARD

A STANDARD IS DEFINED as that which is established by authority, custom, or general consent as a model or example; in general, a definite level, degree, material, character, quality, or the like, viewed as that which is proper and adequate. Often included are: precise definitions, as a basis of accurate description and specification; normal and abnormal service conditions; basis of rating or performance; essential characteristics of materials used and tests for their determinations; and test requirements to demonstrate specified performance, reliability and safety. In brief, it tells "what."

In addition to the foregoing, an AIEE standard may contain material covered in any of the following forms of standards publications.

OTHER AIEE STANDARDS PUBLICATIONS

THESE FORMS of AIEE standards publications can include general principles, test procedures, recommended practices, recommended specifications, guides, or any other material intended to assist in determining whether a standard has been met by a specific piece of equipment, or to establish uniform procedures.

In brief, they are intended to tell "how" or "why" but not "what" in the realm of standardization.

AIEE REPORTS

AIEE REPORTS are those publications distributed for the purpose of making proposals which are in the formative stage available to a wide number of interested individuals for their study and comment.

Division II

AIEE STANDARDS PUBLICATIONS PROCEDURES

I. *General.* A standards publication should perform one of two functions. First, it should establish specific criteria for the acceptable performance of equipment or materials pertinent to the electrical engineering field or, second, it should facilitate communication by establishing test procedures, defining terms or recommending practices, general specifications or guides to use in specific technical fields or for specified equipment. An AIEE standard should always answer "what" and should give a specific basis for ratings and the tests to determine performance. This can apply either to specific equipment or materials or can be written in a basic form to permit its application to many types of equipment or material and, thus, assist in the formation of other standards. Other AIEE standards publications, under a proper title, can answer "how" or "why" or define terms. An AIEE standard may include the type of material covered by any of the other forms of publication; however, whenever standards material is included to any extent the entire publication falls in the category of an AIEE standard.

II. *Types of Standards Publications.* A standard should be entitled "Standard for _____" and the general format given below should be followed to the extent practicable. The title chosen should be as concise as possible consistent with unambiguous definition of the field covered.

Other AIEE standards publications should be given a title defining its specific intent, thus:

Test procedure for _____

A number of titles have been used in the past for AIEE standards publications other than "Standards." These are listed and it is suggested that, where possible, a title be chosen from this list: (1) test procedure; (2) recommended practices; (3) recommended specifications; (4) guides; (5) general principles; and (6) definitions.

AIEE reports may be written on any of the subjects normally covered in a standards publication for the purpose of making proposals which are in a formative stage available to a wide number of interested individuals for their study and comment. The title should take the form of "Report on _____" and should be followed by a statement such as "Published for Comment and Criticism."

Any of these AIEE standards publications with the exception of AIEE reports may be published for trial use, in which case, the words "Proposed for Trial Use" should appear below the title and the title itself should be prefaced by the word "Proposed."

III. *Suggested Format for Standards Committee Publications.*

1. The cover will normally carry the title, AIEE number, date, AIEE monogram, and the statement "Published by AIEE, etc."

2. The inside cover page carries the names of the personnel who generated the text and their committee affiliation.

3. The facing page will be devoted to the table of contents as required.

4. The body of the text should be organized as follows:

The first paragraph of a standards publication should be entitled "Scope" and should clearly define the equipment or technical field it covers with exceptions, if any.

The second paragraph of a standards publication should be entitled "Purpose" and should describe why the subsequent material is needed, the purpose it serves, and should define the state of the art, i.e., it is new, or revised, what other standards are applicable and a statement of any past experience that may contribute to a clarification of the intent of the following material.

The third paragraph should be entitled "Service Conditions" and should clearly state the conditions under which the standard is applicable. These can be environmental, electrical, dimensional, etc. Alternatively, in the case of a standard publication of wide applicability, the negative approach may be used and those conditions can be described under which the standard material is *not* to be applied.

The next section should cover any definitions necessary to the clear understanding of the text. Reference should be made to ASA C42 definitions and departures therefrom, or any new definitions, clearly identified.

The succeeding section of the standards publication may be a general discussion of the text with the detailed material following.

An AIEE Standard may include subject matter normally suitable for other standards publications provided that when such material is included, it is separated from the standards proper and clearly labeled so as to indicate its function; e.g., "Tests," "Operation," or "Maintenance."

IV. *Initiating a Standards Publication.* The Institute encourages standardization work by its members. Any person, whether a member of the Institute or not, may suggest the initiation of work in the field of standards to the Institute. If the suggestion pertains to the field of electrical engineering or the allied arts and sciences and fills a demonstrable need, a group will be organized to generate the standards publication. Such a suggestion may be made either to a technical committee having cognizance over the particular area, or direct to the Standards Committee. The secretary of the AIEE Standards Committee, 33 W. 39th St., New York 18, N. Y.,

has data on available standards publications and other background information which he will gladly supply on request. Or alternatively, any of the liaison representatives, Standards Administrative Subcommittee personnel, or Standards Committee personnel as listed in the latest Organization Manual may be contacted direct. All of these people have access to considerable data on standards matters and are anxious to assist.

V. *Generation of a Standard Publication.* Once a need is recognized for a standards publication within the field served by the AIEE, several methods are available for organizing the specific effort required.

Work may be initiated and brought to fruition by a technical committee or a subcommittee thereof. In the case where an appropriate technical committee does not exist that is interested in preparing the standard in question, the Standards Committee may refer projects to:

1. A standards co-ordinating committee of the Standards Committee.
2. A sectional committee organized in accordance with the procedure of the ASA and preferably functioning under the administrative sponsorship of the AIEE.
3. A subcommittee of the Standards Committee appointed for the specific project.
4. A joint committee of AIEE technical committees.
5. A joint committee of AIEE and other organizations or the group of AIEE representatives thereof.

Reference to a technical committee is the preferred method. In cases where interest exists within a technical committee but its scope does not cover the particular field involved, it is often possible to expand the scope to enable the committee to proceed with the work.

In cases where the interests of one or more other societies are involved, a sectional committee can be organized in accordance with the procedures of the ASA or a joint committee of AIEE and the other organizations may be constituted. Both of these procedures may be somewhat time consuming; but, in the case of revision of standards of some magnitude, initiation of standards work of major scope, or work on projects that may be highly controversial, they are to be preferred. It is suggested, however, that for standards material in the newer technical fields, and other material where speed is desirable, it is possible to form joint subcommittees of technical committees of various societies without the necessity for lengthy approval routines. In the AIEE, a joint subcommittee may be established under a technical committee with approval of the divisional committee. In this case, the generation of the standards publication would take place in the joint subcommittee and the material submitted for approval and review to the technical committees in each society. This could result in approval by several technical societies of an identical standards publication. This is a desirable goal.

In the organization of a committee or subcommittee to work on standards matters, the first criterion of the selection of personnel should necessarily be competence in the field and willingness to contribute to the work involved. However, some attention should be given to the desirability of recruiting personnel from various areas of interest and society affiliation. Manufacturers, users, and the general interest as represented by universities, independent laboratories, and consulting engineers should ideally be in reasonable balance. In addition, personnel with dual memberships in other societies may well be utilized in a liaison capacity to avoid duplication of effort and possible conflict between submitted material from several groups.

Again, in these matters, it is urged that the abilities of the members of the Standards Committee and the liaison representatives be utilized to the greatest extent possible.

VI. *Approval Procedure.* All AIEE standards publications require the approval of the Standards Committee before publication. Where standards material is submitted by outside bodies to the Standards Committee for approval, it is referred to technical committees having a direct interest for their examination and comment before being voted on by the Standards Committee. (Note, however, that the interest of the various technical committees is determined by their replies to the "Standards Interest" questionnaire circulated yearly to each technical committee. Failure to reply to this questionnaire could result in failure to canvass a committee.) However, where the material is prepared under the cognizance of a technical committee, the following procedure should be followed:

Item 1—The working group should prepare sufficient copies to circularize the cognizant technical committee for ballot.

Item 2—When a working group and technical committee has approved the proposed publication, and any substantial objections resolved, 50 copies should be prepared by the working group and submitted to the secretary of the Standards Committee at AIEE Headquarters together with the following information: (a) the purpose and desirability of the proposed standard or revision thereof; (b) reference to any pertinent existing standards; (c) method of voting, letter ballot or voted at meeting; (d) total number of members on the committee; and (e) analysis of results of ballot concerning the standard including (1) number of affirmative votes, (2) number of negative votes, (3) number of waived votes, and (4) number of committee members not returning ballots (failure to vote shall be considered neither affirmative or negative vote); (f) statements regarding any substantial objections to the proposed standard as expressed by one or more members of the committee if such objections have been submitted to the committee in writing accompanied by a negative vote or confirmed to the committee in writing, and the results of efforts to resolve the objections.

On receipt of this information, the secretary of the Standards Committee distributes the copies of the material together with the attached information to the voting members of the Standards Committee for a 30-

day letter ballot with copies of the letter of transmittal to liaison representatives of technical committees. On affirmative vote by three fourths of the members of the Standards Committee appointed by the President, and resolution of any negative votes received, the material will be printed by the Institute and publicized as an AIEE standards publication.

Division III

ASA PROCEDURES

I. *General.* The executive, financial, and general administrative functions of ASA are vested in a board of directors. The functions of formulating rules for the development of standards and the constitution of committees, as well as the approval of standards directly or through a designated agency, are assigned to the Standards Council.

Standards boards serve in their respective fields as general administrative and supervising committees on behalf of the Standards Council. The Electrical Standards Board has jurisdiction in the electrical field. The standards boards consider the desirability of standardization of subjects in their particular fields and initiate new projects, establish scopes, designate sponsors, approve personnel of sectional committees, harmonize conflicts, and perform other more routine functions. The Board of Review is vested with authority to approve standards on behalf of the Standards Council.

The basic test applied in approving a standard as "American Standard" is the fact of the assent, affirmatively expressed, of the groups having substantial concern with the standard.

Standardization projects are undertaken by ASA only upon request. Four recognized methods of processing a standard for approval as American Standard are recognized in ASA procedure. Brief descriptions of these methods follow:

Sectional Committee Method. Upon request for the project, a scope is written and a sponsor (or sponsors) is appointed. (In unusual cases, the sectional committee may act autonomously without a sponsor.) Interested organizations are invited to name representatives classified as producers, consumers, general interests, and distributors, if any. General interest representatives include independent engineers, educators, and persons who are not directly concerned with the manufacture or use of the commodity. AIEE exercises the prerogative of a professional society to designate its representatives as general interest representatives. Substantial balance is obtained by a rule of the ASA procedure that no one classification shall have a majority.

In formulating a standard, a sectional committee has a great deal of latitude—it may compose the standard itself or in subcommittees or it may obtain the subject matter in any way it chooses. It is the group mainly responsible for the technical content.

After a sectional committee has completed a standard and obtained a consensus of its members by ballot, it is submitted by an officer of the sectional committee to the sponsor for its approval. Thence, it is submitted for approval to the ASA Standards Board and finally to the ASA Board of Review. In giving its approval, the sponsor (sponsors) vouches for the technical content but the approvals by the Standards Board and Board of Review are based on evidence that a consensus has been reached according to ASA procedure. In fact, the members of these two boards rarely see or consider the standard itself unless some conflict arises.

Sponsors designated by the standards boards for projects under the sectional committee method are called administrative sponsors. They are selected as competent associations that evince the greatest interest in the subject. Although operation under a single sponsor simplifies administering the work, joint sponsors are sometimes designated when agreement cannot be obtained for a single sponsor. In such cases, the administrative work, by agreement among the sponsors, is often conducted by one of them.

Sponsors also have the responsibility of recruiting the sectional committee personnel with due regard to ASA procedure, providing necessary facilities including secretarial service, and keeping ASA informed of meetings and progress of the work.

Existing Standards Method. An existing standard may be submitted by any responsible body, with certain pertinent information, to ASA for approval as an American Standard.

Approval depends on the acceptance of organizations having a substantial interest in the subject. After a canvass and after favorable replies are received from these organizations, approval as an American Standard, if in the electrical field, is obtained through the Electrical Standards Board and Board of Review.

General Acceptance Method. This method is seldom used. It is intended for simple projects and for cases in which the organization of a sectional committee is judged to be unnecessary. A conference is called of those known to be substantially concerned. If the conference recommends a standard, the assents of groups substantially concerned are obtained and the standard clears through the appropriate standards board and the Board of Review.

Proprietary Method. After a standard has been approved by ASA, a sponsor may be appointed for the development of revisions within its own organization in lieu of a sectional committee, provided its method of formulation affords ample participation of groups substantially concerned. Approval of ASA is obtained through the appropriate standards board and the Board of Review.

II. *Publication of American Standards.* After approval by ASA, a publication is designated American Standard without distinction as to whether it is a specification, code, or guide, or has other significance. The nature of the subject matter should be made evident by

the title. The publication bears the statement "Approved by the American Standards Association" and the date of such approval.

American Standards may be printed in publications of the sponsor and in the case of approved existing standards need not be republished. Although ASA reserves the right to provide for publication in uniform style, it rarely, if ever, has published a standard except in those relatively few cases for which ASA standards boards serve as sponsors.

Provision is made for issue of proposed standards or revisions for a period of trial and criticism prior to formal submission for approval of ASA. Such a proposal is indicated in the caption to be a "Proposed American Standard."

The ASA constitution permits practically all types of standards of national importance to be approved as American Standards. Dimensions or details of construction, for example, can be included quite appropriately.

AIEE INTERACTION WITH ASA

WHEN AN AIEE STANDARDS PUBLICATION, developed and approved within the Institute, appears to be of sufficient scope or importance to the industry to warrant broader dissemination and acceptance than that inherent in AIEE procedures, it may be submitted by the Standards Committee to the American Standards Association for consideration as an American Standard. If the material is acceptable as presented, it would be approved as an American Standard and any future AIEE publication of this standard would include the designation American Standard in addition to the AIEE Standard title. This procedure requires no action by any Institute personnel other than the Standards Committee. However, any interested person may request that the Standards Committee submit such material to the ASA at any time.

Where an American Standard is developed in a sectional committee within the scope of AIEE interests, the Institute may or may not be granted sponsorship. However, regardless of sponsorship, the AIEE is generally invited to supply representatives to participate in the work. The AIEE Standards Committee is authorized by the Board of Directors to appoint such representatives. Appointments are recommended by the appropriate technical committee and usually are for a 4-year period. The instructions issued to each appointed representative are included below.

While our representatives normally act for the AIEE, in instances where the AIEE serves as sponsor or cosponsor of a sectional committee, it is the responsibility of the sectional committee officers to submit the material produced by that sectional committee to the AIEE Standards Committee for approval. Such material is then transmitted to the ASA for their further action.

Instructions approved by the Standards Committee for sectional committee representatives follow:

"You are expected to participate in the formation of American Standards and use your best judgment consistent with the views of the pertinent AIEE committees.

"In addition to seeking information from the technical committees, it is your duty to advise them from time to time of the work being done by the ASA Sectional Committee. The Standards Committee should be advised of any developments in the ASA work which may affect AIEE interests.

"When voting in the sectional committee it is your obligation to reflect the AIEE position on the subject under consideration. If at the time of casting a ballot in the sectional committee for approval of a standard you find that your opinion is at variance with that of the pertinent AIEE technical committees it is your duty to convince them that your views are correct, or to cast the ballot in accordance with their recorded wishes, or to bring the matter to the attention of the Standards Committee.

"In the event of a disagreement between technical committees the matter is to be referred to the Standards Committee. Any unresolved disagreement between members of the AIEE delegation, if there is more than one representative, should also be referred to the Standards Committee."

A picked list of technical committees is made a part of the individual appointment letter.

Lighting Service Areas

Courtesy General Electric

This service area on the recently opened Connecticut Turnpike is illuminated by General Electric fluorescent luminaires to provide added safety for motorists pulling onto and off the busy turnpike at night. The lighting system also serves as a long-distance beacon alerting motorists well in advance that they are approaching a service area. The 4-lamp 6-foot units are mounted back-to-back on concrete standards at heights of approximately 25 feet. The fluorescent light pattern provides uniform, virtually glare-free illumination.

Three Decades of Progress in Electrical Insulation

L. J. BERBERICH
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THE LAST 30 YEARS was a period marked with outstanding advances in certain areas of the field of electrical insulation. This period began with what might be termed the "synthetic chemical age" and ended with the start of the "space age." The progress made during the period may be divided into the following four categories: (1) advances in understanding and application of dielectric theories, (2) development of a host of new synthetic materials, (3) creation of a new system of classifying materials and the revision of the electrical insulation temperature standards, and (4) application of new insulating materials to electrical equipment.

No radically new theories were developed during the period, but gradual progress was made in understanding of dielectric phenomena. Knowledge of conduction and electric breakdown has been refined. Many contributions were also made in relating chemical structure to dielectric properties. All of these advances provided the background information which aided the development of new materials for specific applications.

The progress made in creating new synthetic materials during this period has been truly remarkable. This is an area where "molecular engineering" or the design of molecules for particular applications has met with particular success and much more is expected in the future. The most important advantage of the new synthetic materials available now over those available 30 years ago are greater thermal stability and more predictable properties, thus enabling the operation of electrical equipment more reliably and at ever higher temperatures. These developments have taken the form of new electronegative gases with considerably greater electric strength than air; synthetic liquids with considerably higher thermal stability than petroleum oils; synthetic organic and inorganic papers and textiles with improved properties over those for cellulosic paper and cotton textiles; and a host of synthetic resins, rubbers, and plastics with many and varied special properties not found in the earlier natural gums and resins. All of these materials have been of inestimable value to the apparatus designer who has been quick to apply them.

The problem of thermal rating of electrical equipment and the influence of the thermal stability of materials on this rating has been under periodic review since almost the beginning of the electrical industry. The basis for an important document in this area was developed by Steinmetz and Lamme as early as 1912. This document was later issued as "AIEE No. 1" with the title, "General Principles upon Which Temperature Limits Are Based in the Rating of Electric Equipment." In the earlier editions of this document, materials were placed into various temperature classes according to whether they were "organic" or "inorganic" or combinations of these two broad chemical classifications. With the advent of the many new synthetic materials covering a wide range of thermal stability, this old system of thermally classifying materials was rendered obsolete. During the latter part of the period under discussion, a new system of thermally rating materials based on "generally accepted test and performance" has been developed and incorporated into the 1957 edition of AIEE No. 1 and into the 1957 edition of the corresponding International Electrotechnical Commission document, IEC Publication 85. This new philosophy of rating materials and systems of materials as they are used in electrical apparatus, has had far-reaching effects in that it has given the designer greater freedom in utilizing the new materials.

Brief reference has been made to the fact that new developments in materials have stimulated major advances in equipment designs both from economic and performance standpoints. A few examples in the power apparatus will serve to illustrate this in a striking manner. In the rotating machinery area, 3 or 4 radically new insulations for large generators and motors have been announced in the last 10-year period. All are based on synthetic resins unheard of 30 years ago. In the transformer area, considerable progress can also be attributed directly to the new materials developed during the period. Electronegative gases and vapors have made possible gaseous and "vapor cooled" transformers rated at moderately high voltages. Fire-retardant liquids have resulted in fireproof "askarel-filled" transformers. Silicone and other resins have made possible dry-type transformers rated considerably higher in temperature than the original Class A or 105 C. A number of new synthetic resins and rubbers have resulted in radically new designs of cast and molded instrument transformers. The development of a high dielectric constant liquid for capacitors (capacitor askarel) has enabled a 50 per cent reduction in size over earlier units. These few examples point up the fact that the record of achievement over the past 30 years is an imposing one. The achievements in the materials area were undoubtedly accelerated by the co-operative efforts of physicists, chemists, and engineers—"the triple alliance in electrical engineering." With the coming of the space age even more progress can be expected in the future.

Digest of paper 59-75, recommended by the AIEE Electrical Insulation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1959.

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Improving Stability of AM Directional Antenna Systems

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Recently the FCC amended its remote-control rules to include stations having powers greater than 10 kw or a directional antenna. A directional station applying for remote-control privileges must have an extremely stable antenna system. This article covers design factors which are important in achieving this stability.

THE STABILITY of directional AM antenna systems is important to successful remote control operation. In addition to the provision of an adequate ground system,[1] attention should be given to bonding of the connecting elements, positioning of guy insulators, use of base insulators with sufficient leakage paths, and use of low-loss capacitors and inductors in the phasing and power-dividing networks.[2]

As a further aid to achieving stability, some steps may be taken in the initial design. In arrays in which the currents are not all equal, the designer may examine the design to learn whether inversion is likely to offer an alternative configuration which will possess a greater inherent stability. In cases where inversion fails to give a new solution, circuitry may be employed which offers an advantage. The method of inversion will be illustrated by a number of examples.

THE INVERSION METHOD

AS A FIRST EXAMPLE of the method of inversion let us examine the arrays shown in Figs. 1 (A) and 1 (B). In both cases, the towers are spaced apart one quarter of a wavelength. Fig. 1 (B) is obtained from Fig. 1 (A) by interchanging the two towers, keeping the currents unchanged in the two towers as we move them, but changing the sign of the respective phase angles. The field intensity pattern of the array shown in Fig. 1 (A) may be written

$$\begin{aligned}\bar{F} &= K\,[\bar{I}_1 + \bar{I}_3 \angle -90^\circ \cos\phi] \\ &= K\,\bar{I}_1\,[1 + 0.67\angle -160^\circ - 90^\circ \cos\phi] \\ &= K\,\bar{I}_1\,[1 + 0.67\cos(160^\circ + 90^\circ\cos\phi) \\ &\quad -j\,0.67\sin(160^\circ + 90^\circ\cos\phi)]\end{aligned} \tag{1}$$

The field intensity pattern of the array in Fig. 1 (B) is

$$\begin{aligned}\bar{F} &= K\,[\bar{I}_1 + \bar{I}_3 \angle +90^\circ \cos\phi] \\ &= K\,\bar{I}_1\,[1 + 0.67\angle +160^\circ + 90^\circ \cos\phi] \\ &= K\,\bar{I}_1\,[1 + 0.67\cos(160^\circ + 90^\circ\cos\phi) \\ &\quad +j\,0.67\sin(160^\circ + 90^\circ\cos\phi)]\end{aligned} \tag{2}$$

Thus, we see that the absolute values of equations 1 and 2 as functions of ϕ are identical, if the values of $\bar{I}_1$ in the two equations are equal. An examination of the circuit relations of these two arrays, with due consideration for the effect of mutual impedances,[3] reveals that this equality exists in addition to the other results displayed in Table I. This table shows that in Fig. 1 (B) we have a condition where most of the power flows into antenna 1. In fact, the power into antenna 2 is so small that it may be neglected, and antenna 2 may be operated as a parasitic reflector. This is not a desirable state, because with parasitic operation there is very little control over the magnitude of the current and the phase angle. The arrangement of Fig. 1 (A) would provide an array of greater inherent stability.

The general method of inversion is illustrated by Fig. 2. Fig. 2 (A) shows a general configuration of three antennas. The location of the reference point 0 is purely arbitrary. To invert, each antenna element of the array is moved on a straight line through the reference point to a new location which places the element at the same distance from the reference point as before. This is equivalent to adding 180 degrees to each location angle θ. At the same time, the phase angle of the current in the element is reversed in sign. Thus, Fig. 2 (B) is an inversion of the array in Fig. 2 (A).

The field intensity pattern of the array of Fig. 2 (A) is

$$\begin{aligned}\bar{F} = K\Bigg[& I_A \angle \alpha_A + \frac{360^\circ d_A}{\lambda}\cos(\phi - \theta_A) \\ & + I_B \angle \alpha_B + \frac{360^\circ d_B}{\lambda}\cos(\phi - \theta_B) \\ & + I_C \angle \alpha_C + \frac{360^\circ d_C}{\lambda}\cos(\phi - \theta_C)\Bigg]\end{aligned} \tag{3}$$

or

$$\begin{aligned}\bar{F} = K\Bigg[& I_A \cos\left[\alpha_A + \frac{360^\circ d_A}{\lambda}\cos(\phi - \theta_A)\right] \\ & + I_B \cos\left[\alpha_B + \frac{360^\circ d_B}{\lambda}\cos(\phi - \theta_B)\right] \\ & + I_C \cos\left[\alpha_C + \frac{360^\circ d_C}{\lambda}\cos(\phi - \theta_C)\right] \\ & + j\Bigg\{I_A \sin\left[\alpha_A + \frac{360^\circ d_A}{\lambda}\cos(\phi - \theta_A)\right] \\ & + I_B \sin\left[\alpha_B + \frac{360^\circ d_B}{\lambda}\cos(\phi - \theta_B)\right] \\ & + I_C \sin\left[\alpha_C + \frac{360^\circ d_C}{\lambda}\cos(\phi - \theta_C)\right]\Bigg\}\Bigg]\end{aligned} \tag{4}$$

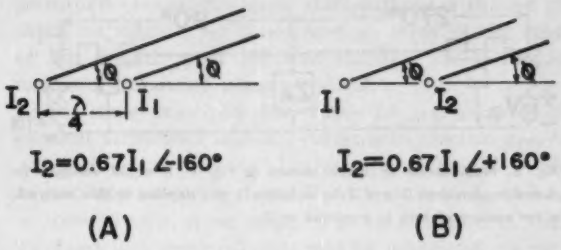

Fig. 1. Two-tower antenna system with the towers ¼ wavelength apart. The result of interchanging the towers without changing tower currents is shown in (B).

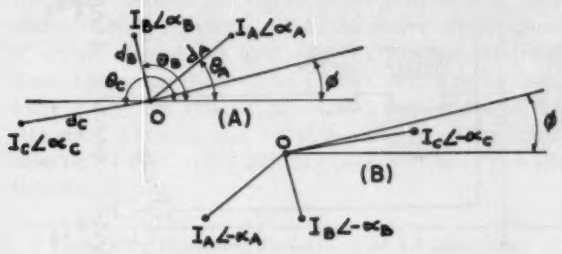

Fig. 2. General inversion method with reference point arbitrary. The result of inverting the array in (A) is shown in (B).

The field intensity pattern of the inversion in Fig. 2 (B) is obtained by writing $-\alpha$ for α and $-d$ for d in equation 4. It is readily seen that the absolute values of equation 4 remain unchanged.

Another example of the method of inversion applied to a 3-element array is shown in Fig. 3. The arrangement of Fig. 3 (A) affords a reasonable distribution of power into the three elements,[4] while the inversion requires a less desirable distribution. Table II displays the operating conditions relating to the two configurations.

A striking example of the large changes in effective resistance and relative power distribution is displayed by the 4-element array depicted in Fig. 4. In the arrangement of Fig. 4 (A), the total power of the transmitter is fed to antenna 1 and the other antennas operate as parasitic elements. The inversion of Fig. 4 (B) completely rearranges the power distribution, as shown in Table III.

Although the method of inversion offers a powerful means of obtaining a desirable redistribution of antenna parameters, it fails when a symmetrical array is encountered. This condition is illustrated by the array depicted in Fig. 5, in which it may be seen that the inverted condition is identical with the original condition of Fig. 5 (A). However, for an array of this type, we may resort to some rather special circuitry to attain stability and to help in the problem of remote control.

Full text of a conference paper presented at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Recommended for publication by the AIEE Television and Aural Broadcasting Systems Committee.

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PHASE AND AMPLITUDE CONTROL UNDER STABLE CONDITIONS

Before discussing the details of circuitry which is applicable to the array shown in Fig. 5, we shall examine some circuit elements that are useful. In Fig. 6, load R is fed through a transmission line of characteristic impedance Z_c with a matching section at the end to convert the resistance R to match the transmission line. We choose the reactance elements X_1, X_2, and X_3 so that this match is effected and, at the same time, obtain a phase shift of ϱ degrees.[5] This phase shift is chosen so that ϱ plus β is 90 degrees, or an odd multiple of 90 degrees. When the total phase shift designed into the over-all feed system is 90 degrees, the output lags the input voltage by 90 degrees, and a total phase shift in the feed system of 270 degrees results in an output current which leads the input voltage by 90 degrees. In either case, the output current remains constant in phase and magnitude when R changes in magnitude or becomes reactive. This condition may be used to insure stability.[6]

The circuitry of Fig. 7 shows a method of applying this principle to obtain two antenna currents which are locked in phase opposition and in magnitude equality. This arrangement could be used to feed antennas 2 and 3 of Fig. 5. Then, if the current in antenna 1 were obtained by a separate transmission-line feed, this latter antenna would induce equal voltages in antennas 2 and 3. These voltages would be applied to the network of Fig. 7 as shown in Fig. 8. The two voltages when applied to this circuit would deliver a net current of zero to the impedance Z_A, when Z_A is located at the feed point of the network of Fig. 7. In turn, the net voltage induced in antenna 1 by the two currents in phase opposition in antennas 2 and 3 would be zero. These circuits may then be applied as shown in Fig. 9 to obtain the array conditions of Fig. 5. If the power divider of Fig. 9 permitted control of power division with a fixed phase shift and if the phase shifter

Table I. Operating Conditions of 2-Tower Array Shown in Fig. 1.

	Current, amperes		Resistance, ohms		Power, watts	
	I_1	I_2	R_1	R_2	P_1	P_2
Fig. 1(A)	6.04	4.05	20.5	15.5	746	254
Fig. 1(B)	6.04	4.05	27.18	0.61	990	10

Table II. Operating Conditions of 3-Tower Array Shown in Fig. 3.

	Fig. 3(A)	Fig. 3(B)
Current, amperes		
I_1	4.21	4.21
I_2	4.21	4.21
I_3	2.105	2.105
Resistance, ohms		
R_1	20.89	26.52
R_2	21.61	25.75
R_3	56.2	16.92
Power, watts		
P_1	370	471
P_2	383	456
P_3	247	73

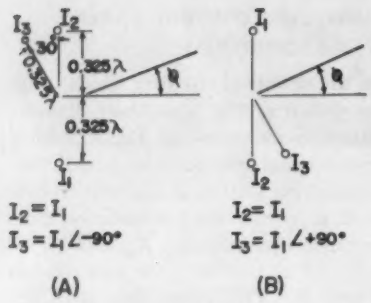

Fig. 3. Example of inversion method applied to 3-element array. System in (A) after inversion is shown in (B).

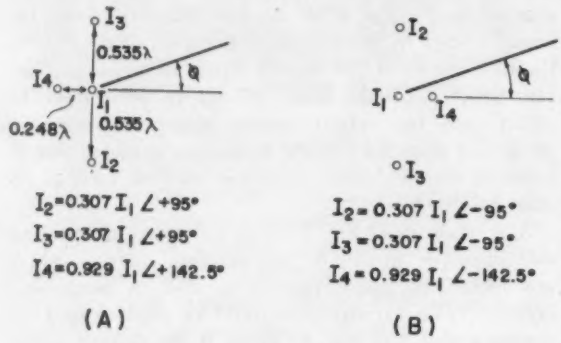

Fig. 4. Four-element array. (A)—Configuration when all transmitter power is fed into antenna 1 and other antennas act as parasitic elements. (B)—Same system after inversion with power distributed among all four elements.

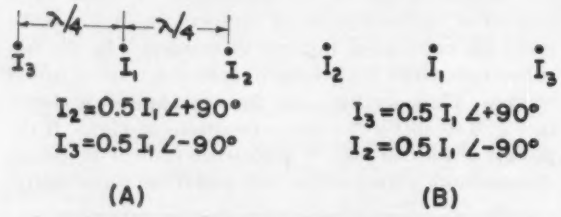

Fig. 5. Under certain conditions of current symmetry and geometrical symmetry, inversion fails to produce a new result.

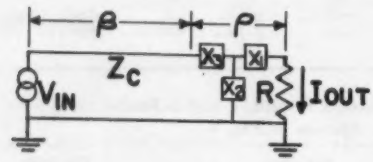

Fig. 6. Typical line, with load R and characteristic impedance Z_c.

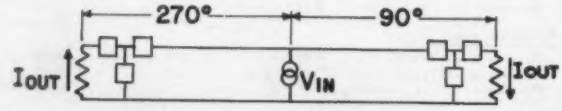

Fig. 7. Circuitry in Fig. 6 applied to obtain two antenna currents of constantly equal magnitude locked in phase opposition.

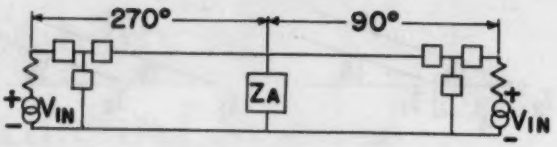

Fig. 8. Modification of circuit shown in Fig. 7. If equal voltages induced in antennas 2 and 3 by antenna 1 are applied to this network, a net current of zero is produced at Z_A.

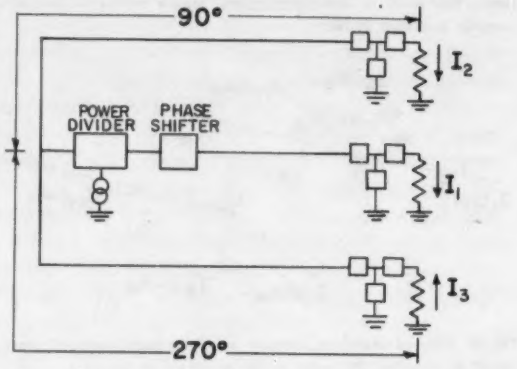

Fig. 9. Method of obtaining the array conditions of Fig. 5 using circuits shown in Figs. 7 and 8.

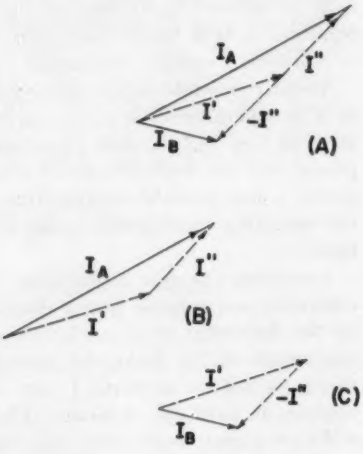

Fig. 10. Construction showing how antenna currents may be broken into a useful set of components.

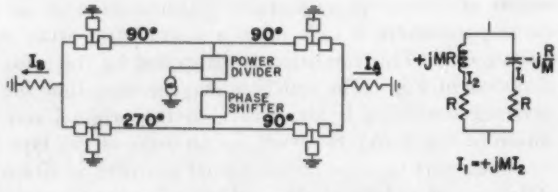

Fig. 11 *(left)*. These distribution circuits make use of the current shown in Figs. 10 (B) and (C). Fig. 12 *(right)*. Simple power-dividing network. The resistances represent inputs of two matched transmission lines or other equivalent loads. The inductance and capacitance are variable to provide control of the power division.

permitted continuous phase shift without a change of input impedance, we could feed an array of the type of Fig. 5 with great inherent stability and a simple means of obtaining remote control.

The same principles may easily be applied to a 2-element array with unequal currents in the two towers (or with equal currents). Let us suppose that we wish to feed two antennas, A and B, with currents I_A and I_B at some chosen phase angle. The construction of Fig. 10 shows how these currents may be broken into a useful set of components. Figs. 10 (B) and (C) show that $\overline{I}_A$ equals $\overline{I}' + \overline{I}''$ and $\overline{I}_B$ equals $\overline{I}' - \overline{I}''$. The circuit arrangement of Fig. 11 induces a current I' in each of the loads through the upper set of transmission lines and matching networks, while the lower set produces I'' in the right-hand load and $-I''$ in the left-hand load. The power divider and phase shifter provide complete control of relative phase and amplitudes of the two total currents, and the phase lengths of the transmission lines and building-out sections provide inherent stability.

Table III. Operating Conditions of 4-Tower Array Shown in Fig. 4.

	Fig. 4(A)	Fig. 4(B)
Current, amperes		
I_1	5.23	5.23
I_2	1.61	1.61
I_3	1.61	1.61
I_4	4.86	4.86
Resistance, ohms		
R_1	36.45	6.19
R_2	0	42.75
R_3	0	42.75
R_4	0	25.73
Power, watts		
P_1	1000	169.
P_2	0	110.5
P_3	0	110.5
P_4	0	610

A simple power-dividing method is shown in Fig. 12. Here the two resistances R may be the inputs of two matched transmission lines or other equivalent loads. The inductance and capacitance are the variable elements which provide the control of power division. The current in the capacitive leg leads the current in the inductive leg by 90 degrees and is M times the current in the inductive leg. The input impedance of the network is a pure resistance of R ohms.[7]

The circuit shown in Fig. 13 has useful properties as a continuous phase shifter. The quarter wavelength of transmission line has a characteristic impedance equal to the load impedance R. The input impedance is a pure resistance of R ohms. The two variable elements are the identical inductances, each with a reactance of KR ohms. The output voltage remains equal to the input voltage and shifts in phase according to the relation

$$\overline{E}_{out}/\overline{E}_{in} = 1.0 \angle \theta \qquad (5)$$

where

$$\tan \theta = \frac{-2K}{1 - K^2} \qquad (6)$$

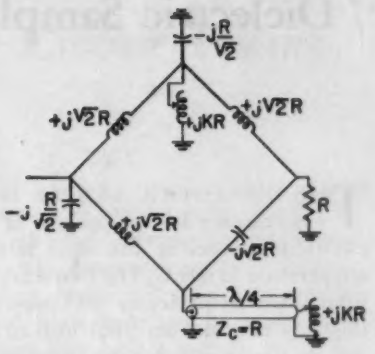

Fig. 13. Circuit of a continuous phase shifter.

As K varies from zero to infinity, θ progresses in a lagging fashion from zero to 180 degrees.

If the two variable inductors are replaced by variable capacitors of $-KR$ ohms, the phase shift is given by

$$\tan \theta = \frac{2K}{1 - K^2} \qquad (7)$$

CONCLUSION

A METHOD OF INVERSION which is applicable to some directional arrays is explained and examples show how, in some cases, undesirable impedances may be avoided. Circuit arrangements which achieve inherent stability, as well as useful power-dividing and phase-shifting networks, have been developed.

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3. Directional Antennas, G. H. Brown. *Proceedings*, Institute of Radio Engineers, vol. 25, no. 1, Jan. 1937, pp. 96, 97, 100.

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7. Adjusting Unequal-Tower Broadcast Arrays, G. H. Brown, J. M. Baldwin. *Electronics*, New York, N. Y., Dec. 1943, p. 123.

Gas-Filled Transformer

A gas-insulated power transformer rated 10,000 kva has been shipped from General Electric's Pittsfield, Mass., plant to the Pennsylvania Power & Light Company, Allentown, Pa. It will step down 69,000 volts to 12,470 volts in an outdoor substation at Allentown.

Insulating medium and primary coolant is sulfur hexafluoride (SF_6), circulated through the core and coils by blowers. A feature is that motors on the blowers can be readily inspected without removing gas from the tank. The transformer weighs 47,900 pounds, compared to 66,500 pounds for oil-filled unit of similar rating, and has a sound level several decibels lower.

Dielectric Sample Holder for Thin Sheet Insulation

M. C. HALLECK
MEMBER AIEE

THE DIELECTRIC SAMPLE HOLDER described was designed for the purpose of measuring the dielectric properties of thin sheet insulation from room temperature to 600 C. The frequency to be covered was from power frequency to 100 kilocycles and the sample thickness ranged from 0.001 inch to 0.050 inch. In the design, considerations were given to a method of applying heat, ease of changing samples, accuracy of measurement and the time required to obtain the data. The holder was designed to connect to the type *1610A* General Radio Capacitance Measuring Assembly or any similar type capacitance bridge.

The cell consisted of an inner electrode, a guard electrode, and a high-voltage electrode. The inner electrode and the guard electrode are fastened to two concentric cylinders as shown in Fig. 1. The two cylinders are held rigid with respect to one another by two sets of mica washers located just below center and at the lower end of the two cylinders also shown in Fig. 1. The air space

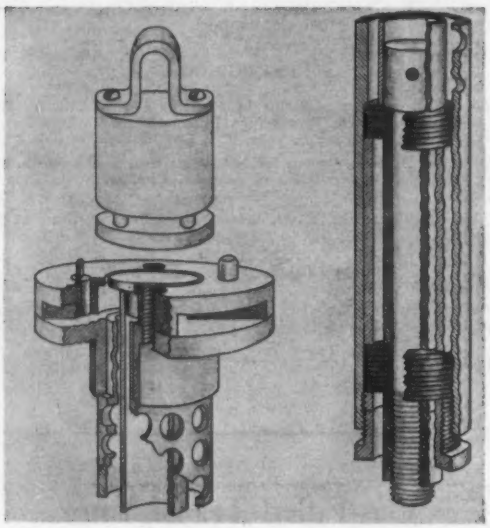

Fig. 1. Inner electrode and guard electrode fastened to two concentric cylinders.

between the inner and guard electrode is between 0.0015 inch and 0.002 inch. The high-voltage electrode was made larger than the inner electrode in accordance with standard practices. The high-voltage electrode consists of two sections in order to provide a more uniform temperature through the sample in a shorter period of time. All electrode surfaces are gold plated to insure good electrical contact over the entire temperature range. Small air spaces between the electrode and the sample are eliminated by placing a very thin film of platinum on the insulation surface by the sputter process. Jigs and masks were used to align the platinum surface on the sample with the inner electrode surface. The masks and prepared sample are shown in Fig. 2.

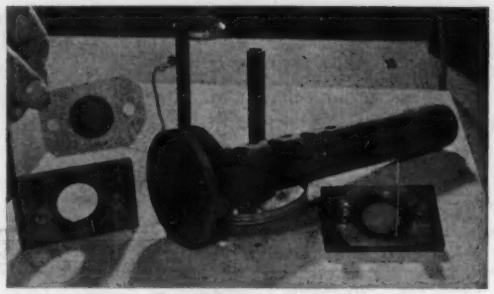

Fig. 2. The masks and prepared sample.

Temperature was obtained by lowering an inverted oven over the sample holder. The oven has an inside diameter of 6 inches and a depth of 10 inches. It was designed to operate continuously at any temperature between room temperature and 800 C.

Accuracy largely depends upon the uniformity in sample thickness and the ability to measure the true sample thickness. Sample thicknesses were measured with precision micrometers to the nearest 0.0001 inch. For a 2.5 mil sample an error of 4% could be expected. Measurements were taken on thin sheet insulation materials up to their recommended temperatures. The data compared very well with data taken on other sample holders at room temperatures. Inasmuch as no accuracy of measurement was given with the data, a comparison was all that could be made. It was concluded, however, that this sample holder was as accurate as those normally used for measuring the dielectric properties of thin insulation material at room temperature.

Digest of paper 58-116, "Sample Holder for Thin Sheet Insulation Dielectric Measurements up to 600 C," recommended by the AIEE Dielectrics Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Published in AIEE *Power Apparatus and Systems*, June 1958, pp 343-48.

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Aircraft Switch and Relay Inductive Circuit Testing

J. P. DALLAS
MEMBER AIEE

THE MAJOR FACTOR determining the life of current-carrying contact systems is contact metal erosion resulting from electric discharge in the contact gap. In general, contact system deterioration is proportional to the energy dissipated in the contact gap. Typically, a 5-ampere aircraft fire extinguisher solenoid may discharge 2.69 joules of energy in the contact gap compared to an 0.2 joules of energy in the contact gap for a 5-ampere resistive circuit.

The present military specifications contact system test requirements are far from reality. The performance of equipment designed to meet such test requirements may not be entirely relevant. Current *MIL* specifications such as *MIL-R-6106C* specify inductive circuit contact system tests using standard inductance *AN-3179* to produce a test circuit L/R ratio of 0.026 seconds. *AN-3179-6* six ampere test inductors are likely to show as much as 100 per cent difference in the measured value of L. The same inductances may show as much as 300 per cent variation in the value of L as the result of the method of measurement. This is because these iron-cored inductances are operated at or beyond saturation. The purpose of this discussion is to suggest a more realistic approach to this problem.

The energy stored in inductance is usually defined as: joules $J = \frac{1}{2} LI^2$ where L equals the inductance of the coil and I equals the current in amperes. This expression is not directly useful in computing the energy dissipated in a circuit interruption contact gap. The stored energy of the inductance is partly dissipated in eddy currents, hysteresis losses, I^2R losses, and dielectric losses. Because part of the circuit interruption cycle and arc is of high-frequency nature, these losses are commonly very large. A solid-core solenoid may dissipate 80 per cent of its theoretical stored energy in such losses. We could write the expression for the inductance stored energy available to the circuit interruption contact gap as $J_c = \frac{1}{2} LI^2 - P$, where J_c equals the joules of energy available to the circuit interruption contact gap and P equals the sum of the energy losses dissipated in the coil core and other parts of the circuit outside of the contact gap. From the foregoing, it is obvious that the L/R ratio is not a useful way of defining the inductivity of a contact system test circuit.

To insure that iron core test inductors can be calibrated within useful tolerances, the following limitations must be observed: (1) operation substantially below saturation of the iron, (2) operation at high enough minimum flux densities to insure uniform and calibratable value of inductance, and (3) each core assembly should be calibrated by plotting differential inductance per turn squared against ampere turns. This may be accomplished from an oscillograph recording of the current rise time-constant for ampere turns varied from maximum to minimum values in order to avoid major hysteresis loop inaccuracy. From such a curve, the range of ampere turn change which will yield a reasonably constant incremental inductance can be selected. A typical inductor design may have a usefully stable inductance between 2,000 and 10,000 ampere turns if a large air gap is used.

A contact system test procedure which can closely simulate aircraft and missile inductive loads and can be calibrated to a practical degree is proposed as follows:

1. Joules of circuit interruption contact gap energy for typical aircraft and missile inductive circuits judged to be critical are computed from oscillograms of circuit interruption contact gap currents and voltage. Standard laboratory techniques with a dual beam oscilloscope and recording camera will provide this data. It is proposed that specifications should call out such suitable values of contact gap energy in inductive circuit tests.

2. Use an inductor constructed with sufficient air gaps and operated at flux densities that have been determined to maintain a nearly constant incremental inductance throughout its range of adjustment. The inductor should be tapped to provide close adjustment. It will be useful to determine the core constant in microhenrys per turn squared. The required number of turns for a given inductance will be $N = \sqrt{L/K}$ where N is the number of required turns, L is the required inductance in microhenrys, and K is the core constant in microhenrys per turn squared.

3. In a test circuit, the inductor should be adjusted to a value which will produce in the contact gap of the test sample the specified joules of circuit interruption energy. The specified value of joules of circuit interruption contact dissipated energy should be the result of the determinations discussed in item 1. The adjustment of the inductor to produce the specified gap energy may be checked with a dual beam oscilloscope equipped with a camera.

4. For an approximate adjustment of the test inductor, determine the equivalent effective inductance L_k for producing the specified energy in the contact gap by substituting the appropriate values of J_c and I in the expression $L_k = 2J_c/I^2$ where L_k equals henrys of inductance, J_c equals the specified contact gap circuit interruption energy in joules and I is the current in amperes.

Digest of paper 58-841, "Aircraft Switch and Relay Inductive Circuit Test Loads," recommended by the AIEE Air Transportation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Applications and Industry*, 1958.

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Microwave by Wire

T. HAFNER

Microwave by wire or surface-wave transmission by G-Line is a new way of propagating microwaves in nonradiating mode along an insulated wire which does not require FCC allocation. Its simplicity and low loss permit it to replace economically coaxial and radio transmission. Practical examples are given for G-Line components and complete G-Line systems.

AT FIRST, communications had much in common with its public companion, railroads—utilizing the same stretches of land on which long metal lines carried everything man created at high speed; the physical by rail, the intelligence by wire. And, like the railroads, communication by wire is to be affected by the competition of other communication carriers, such as radio, using public rights of way—the air.

The trend to the air of the communications business at first was resisted circuitwise by the wire lines. Phantom circuits and low-frequency carriers were used to increase wire capacity, and when this proved insufficient, high-frequency transmission lines and especially coaxial cables followed.

However, with the realization of gas-filled coaxial tube lines carrying television and voice channels across the continent, long-distance communication by cable became complex and uneconomical as compared to radio relays.

As a result, the number of public FCC allocated channels expanded, at first over line-of-sight distance and now gradually extending through horizon techniques into hundreds of miles.

However, here too expansion has its limits, technical as well as economical. The number of available radio channels is necessarily limited; and restriction of the band width and extension of the carrier range to make room for new channels are again accompanied by increasing complexity and expense.

Thus, wire lines, independent of FCC allocations may again become competitive if not indispensable.

Obviously, in order to compete successfully with radio techniques, wire lines must meet stringent requirements:

1. Band width and carrying capacity must be much larger than in present systems.
2. They must be able to use existing physical rights of way, especially pole plants.
3. They must cost less.

The answer to these requirements is a simple wire with a dielectric coating—the Surface Wave Transmission Line or G-Line, named after the physicist George Goubau.

A special article recommended by the AIEE Wire Communication Systems Committee.

T. Hafner is president and secretary, Surface Conduction, Inc., New York, N. Y.

SURFACE WAVE TRANSMISSION

DR. GOUBAU was the first to excite and propagate nonradiating surface waves along such a conductor. He also was the first to use it in high-frequency transmission in place of coaxial cable or directed radio transmission.

Of particular interest is the range from about 100 to 1,000 mc, where we now have simple high-power transmitting and receiving tubes, and where coaxial cables have high losses.

In fact, the G-Line may well be regarded as a logical development of the coaxial cable.

THE G-LINE

EVERYONE KNOWS how a bare smooth conductor, if properly excited, will lose its entire energy in the form of radiation; it becomes an antenna. However, when

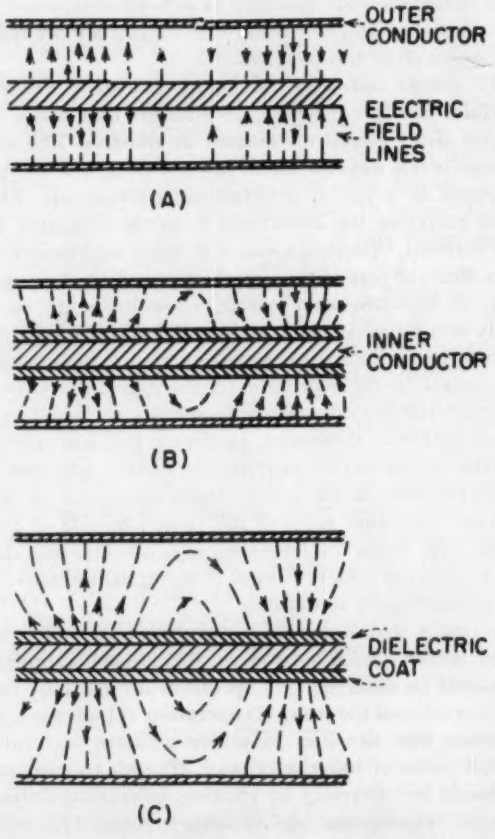


Fig. 1. G-Line derived from coaxial cable.

coated with a thin low-loss dielectric layer, the field energy becomes concentrated within an invisible coaxial cylinder of relatively small radius.

To understand this surface-wave effect and how the coaxial cable becomes a G-Line, imagine the following experiment:

Take a normal coaxial cable with full insulation, say, polyethylene, and a low impedance of 60 ohms (Fig. 1a), and gradually increase the diameter of the outer conductor while retaining the diameter of the dielectric. This will increase the impedance but it also changes the field configuration so that the field lines will receive axial components, some of which will close without touching the outer conductor. If we now move the outer conductor still further (Fig. 1c), practically all the field lines will return. The current in the outer conductor will be reduced to zero, and will return as a pure dielectric current over the surrounding dielectric layers of polyethylene and air.

WIRE LOSS

Inasmuch as the loss of the inner conductor of this coaxial cable decreases approximately in inverse proportion to the impedance 1/Z, with the outer conductor disappearing and this coaxial cable becoming a G-Line of, say, 360 ohms, the loss of the remaining G-Line will amount to only 1/6 of that of the 60-ohm coaxial cable with which we started. In both cases, the dielectric loss must be added which is rather small and negligible for the frequency range under consideration.

This effect is confirmed by measurements.

For practical G-Line uses, it is important and possible to define the parameters of the G-Line in the manner customary for coaxial cables.

One such parameter is the field radius which covers more than 90% of the electromagnetic field, and decreases proportionally with increasing frequency.

G-Line with an outer diameter of twice the inner diameter *(D=2d)* has a field radius from about 6 feet at 100 mc to 6 inches at 1,000 mc.

Thicker dielectric layers reduce the field radius but also increase losses.

In view of form and size of the field of the G-Line, there are other losses in addition to the wire loss, namely:

1. losses in transit from and to coaxial feeder cables,
2. radiation losses due to sag and changes in direction,
3. losses caused by supports and disturbing objects appearing in the space of high field concentration.

ADDITIONAL LOSSES

In the frequency range under consideration (100 to 1,000 mc), normally a coaxial cable is used to feed the energy to and from the G-Line. This involves a broadband transition from coaxial wave to surface wave, substantially free of reflections and radiation, and an impedance transformation between a coaxial cable of about 100 ohms and a G-Line of about 400 ohms, where

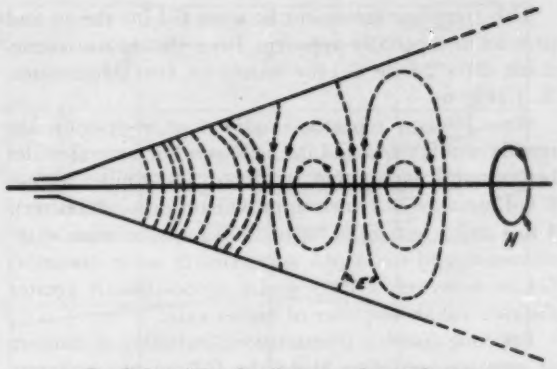


Fig. 2. Launching of surface wave by metal cone.

the current of the outer conductor of the coaxial must be continuously reduced and gradually converted into the dielectric return current of the G-Line.

The solution is simple—a metal cone.

COUPLINGS

If we bear in mind the change in field-line configuration of a coaxial cable with increasing outer conductor and increasing impedance (Fig. 1), we arrive at the field-line configuration required for exciting a G-Line with the aid of a cone (Fig. 2). With proper form of construction, excitation and decoupling losses can be held down to less than 1 db, which, of course, is negligible in an extended G-Line system, especially when compared to the corresponding losses of coaxial cables in a frequency range above 100 mc.

Cone constructions, such as used by the U. S. Army in mobile radio relay systems, come very close to an optimum adaptation of coaxial cable to G-Line (Fig. 3).

SUSPENSION

The support of the G-Line is unconventional but simple.

Generally, the wave front should be disturbed by as few and as small supporting elements as possible.

In practice, therefore, as at Fort Monmouth, N. J., and Helena, Mont., the G-Line wire was suspended on nylon strings, such as V-shaped loops (Fig. 4) which proved simple and stable.

To reduce loss, a 90° bend was divided in a trolley-like fashion into several smaller bends (Fig. 5), all supported on the same pole.

Typical G-Line systems, assuming six miles between amplifiers, gave the following additional losses:

Condition	*Loss*
Line sag at 150-foot pole distance:	0.5 to 1 db per mile
Approach to pole, supports and cones:	less than 1 db per mile
Changes in direction:	3 db per mile (less than 2 db along railroads)
Total:	about 4.5 db per mile (less than 3.5 db along railroads)

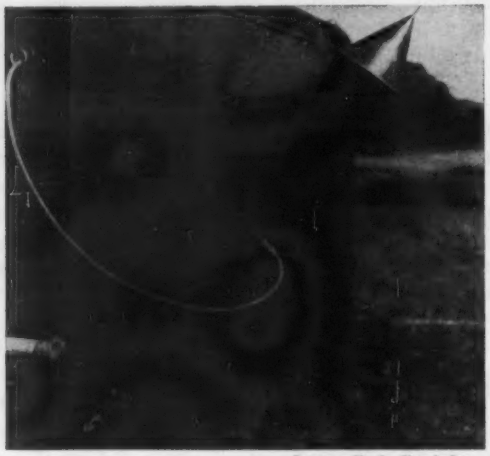
TOTAL LOSS

Because these additional losses are smaller than the wire loss, the total or line loss of a G-Line system is very much below that of coaxial cable.

This complete agreement between G-Line theory and practice is especially apparent from the measurements made on a 2-mile G-Line system at Fort Monmouth, N. J. (Fig. 6).

Since low-cost repeater amplifiers of 60-db gain are readily available, a G-Line will run for several miles before requiring another amplifier: 3 to 4 miles for no. 8 G-Line wire (0.3 inch approximate outer diameter); 4 to 5 and 5 to 6 miles for no. 6 (0.4 approximate outer diameter) and no. 4 (0.5 approximate outer diameter) G-Line wire, respectively, and a proportionally greater distance for an amplifier of higher gain.

For long-distance transmission, including a number of repeater amplifiers along the G-Line, the economy against coaxial cable becomes particularly obvious.



Courtesy U. S. Signal Corps.

Fig. 3. Launching cone of antenna line for telephone transmitter manufactured by Prodelin Inc.

A system of, say, 20 amplifiers each of 60 db gain, will carry a 0.5-inch coaxial cable over a distance of about 8 miles and a 0.5-inch G-Line over 120 miles assuming a frequency range between 100 and 200 mc.

WEATHER

THE INFLUENCE of the weather is small in the frequency range under consideration. The line loss is not sensibly increased by rain, snow, thaw, or frost, except wet snow or water ice of extended thickness. This can be compensated for by the usual automatic control of the amplifier gain, or by electrical heating.

For very high frequencies, up to 6,500 mc and more, Lignes Telephoniques et Telegraphiques, a French licensee, designed a protected G-Line where a polyethylene-foam layer displaces the weather effects or the weather-affected surface beyond the field of maximum field intensity.

SEVERAL WIRES

INSTEAD OF a single cylindrical conductor with a concentric dielectric, several conductors twisted about each other or other types of conductor could be used. A standard twin wiretape, for example, will carry between its wires d-c or a-c power, or low-frequency carriers, and along its surface, high-frequency carriers, thus covering with low loss a broad frequency band extending from 0 to 1,000 mc.

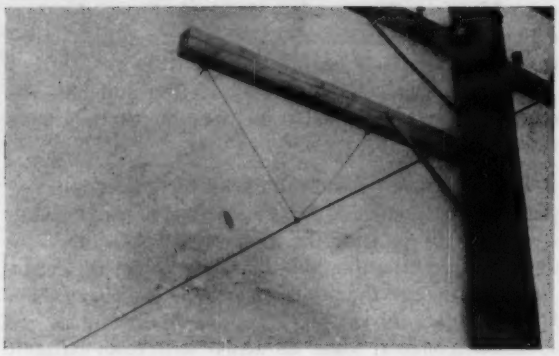


Fig. 4. Straight G-Line wire on V-shaped nylon string.

For better exploitation of available pole space, several G-Lines may be arranged in parallel with practically no cross-talk distortions. Also coupling between G-Line and a bare wire line is very small. If mounted on telephone poles, the G-Line may have a distance of about half a wave length and even less from the other wires. The G-Line is very insensitive to external disturbances. For instance, ignition noise from automobiles was never observed in installations along highways.

FIELDS OF APPLICATION

AS APPARENT from the foregoing data, the main application of the G-Line, because of its low cost and low loss is to compete with and replace open wires, coaxials, wave guides and radio and television transmitters.

Courtesy of Helena TV Inc.

Fig. 5. G-Line wire curve on nylon strings.

It will, however, also interest its competition; i.e., these same transmitters.

A radio or television antenna feeding line, for example, of 1,000 feet length at 500 mc will cost about 15 per cent of the cost of a coaxial cable of equal loss. It may also be mounted more cheaply, either simply suspended or running along one side of the mast, thereby dispensing with elaborate ground installations otherwise required to connect the foot of the mast with the building itself (Fig. 7).

The power limit of a G-Line is extraordinarily high because heat is immediately carried away through convection and radiation, and also because the current for a given power is smaller, which is important for high power vhf, and uhf transmitters.

Longer G-Lines are used in booster antenna systems, where, for best reception and transmission on the same frequency, receiving and transmitting antennas must be set far apart and interconnected with low loss and low cost transmission lines. Similar economic considerations apply to any type of closed circuit.

Thus, in this country community television proved a successful example of long-distance G-Line application. There, normally a coaxial cable is used to carry a signal received from a high amplitude point to a low signal area for distribution to individual homes. In view of the high loss in greater distances, this coaxial feeder cable had to be provided with many closely spaced amplifiers and compensating networks. This is not only expensive but also frequently unfeasible because it affects the quality of the television picture.

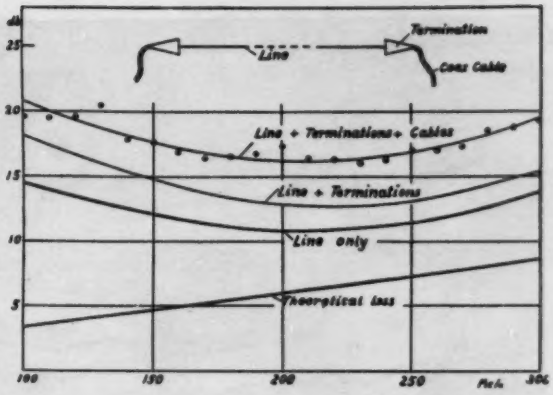
The G-Line, with its low loss, and with the same number of amplifiers reaches much further. This makes the G-Line practical wherever pole systems exist, and indispensable wherever r-f channels are not available, or where distances are so short or the topography or number of channels are such as to rule out microwave radio transmission.

G-Line planning, therefore, would apply with particular effect to the communication needs of existing pole owners such as telephone, telegraph, railroad, power, pipeline, and other public services, and of course not only to the transmission of pictures, voice, and teletype but also to the transmission of radar screens and any other broadband intelligence to an extent and at costs not reached by any other transmission technique.

Along railroads and highways, G-Line installations have another advantage as compared to open wires, coaxial cables, and even microwave radio.

With proper dimensioning of the G-Line field and with an appropriate antenna or a short G-Line section mounted on a vehicle, train, or automobile, G-Line signals may be picked up continuously by the vehicle which, in turn, may communicate over the G-Line with other stations located along the line.

This not only will serve existing types of signaling and communication between vehicles and stations, but also will permit the transmission of all sorts of new broad-band information, such as instrument panels,



Courtesy U. S. Signal Corps.

Fig. 6. Total G-Line losses for 2-mile G-Line no. 4.

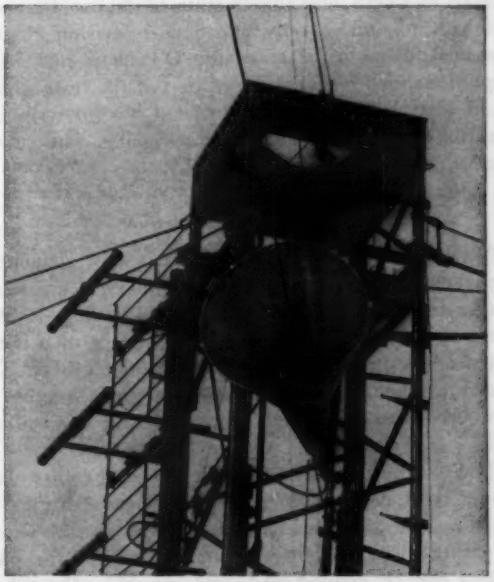
documents, traffic data, etc. This, for example, presents the first possibility of placing television on trains.

It is quite obvious that wired television (i.e., television not requiring FCC channels) stands greatly to profit from G-Line technique. This applies to industrial and educational users as well as to the various "pay as you see" ventures now greatly handicapped by the cost of coaxial cable transmission and, therefore, forced to apply for FCC channels which so far were denied them.

COST

We know from experience that, compared to a corresponding coaxial cable, a G-Line saves at least 75 per cent in construction and maintenance.

For example, the 14-mile Helena G-Line replaces, at a cost of only $12,000 or $900 per mile, a coaxial cable which would have cost $45,000 to $50,000. At present



Courtesy Rhode & Schwartz, Munich, West Germany

Fig. 7. Launching cone of G-line connected to receiving antenna.

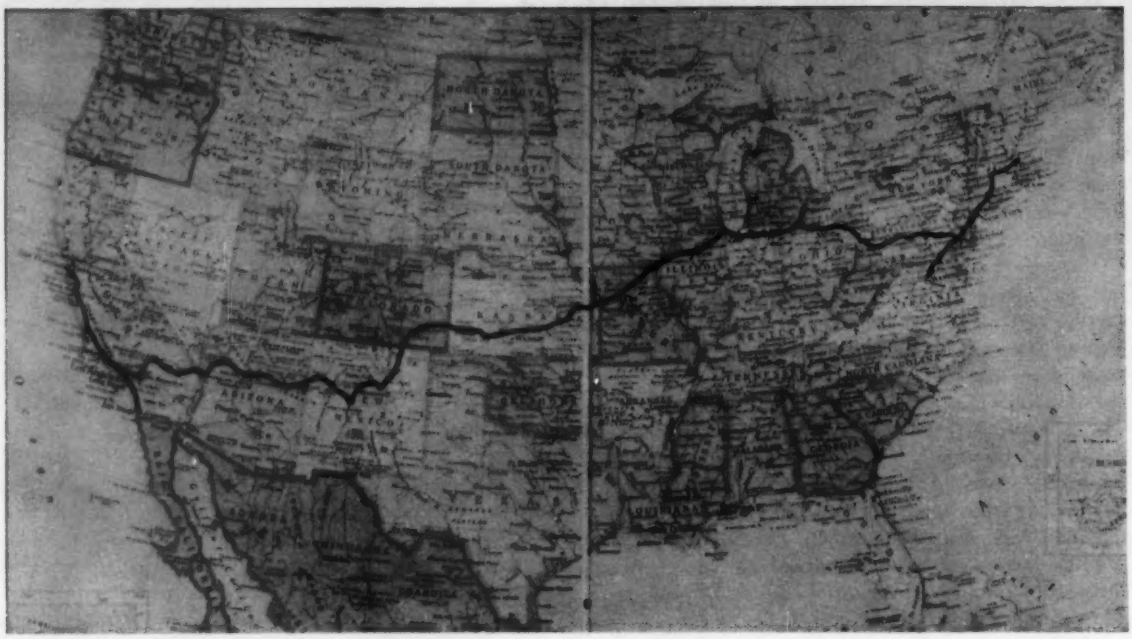


Fig. 8. Transcontinental G-Line project.

copper prices, this cost could be brought down to about $600 per mile, and even lower with a 5 per cent copper-plated steel wire, such as manufactured by the National Standard Company.

The Helena G-Line which starts in snow and ice at an elevation of more than 6,000 feet, has been operating satisfactorily and profitably for about 3 years under rather severe atmospheric and topographic conditions. During this time, the number of homes connected to it increased from 500 to 2,500; i.e., the entire city. It has proved its worth, and this in spite of the fact that with the transmission of only one 6-mc television channel the broad-band capacity of the G-Line is not nearly exploited. Such G-Line systems permit the transmission of at least 100 mc, or 10 television channels simultaneously or other broad-band intelligence, and several thousands of voice channels.

CONCLUSIONS

Microwave by wire, or G-Line is a new element in the transmission of electromagnetic waves. It was found that, apart from the spaces within and without a cable, there exists a new space along the surface of a wire—a space not interfering with any of the others. This added to the known radio space a great number of new broad-band channels not requiring FCC allocations.

The G-Line replaces open wires, coaxial cables, wave guides, and even r-f transmission. The conditions for exciting and propagating surface waves can be shown in a rather comprehensive manner, and G-Line parameters can be defined and used just as well as those of a coaxial cable.

The excitation elements and the disposition of the G-Line are practical and completed systems have verified the results of the theoretical investigations. Abroad, German, French, and English development and especially research have gone much further and into very high frequencies.

The fields of G-Line operation shown represent only a small section of the range of applications. Of these, public utilities such as railroads will be particularly adapted to exploiting their extensive pole plant to carry broad-band communications not only for themselves but also for others. Thus, hundreds of thousands of miles of pole plant belonging to the railroads and other public utilities, and falling into obsolescence, may again become valuable rights of way.

In contrast to point-to-point radio linkage, microwave by G-Line suggests the concept of continuous penetration of vast territories with voice and television channels, of broad communication highways crossing and joining entire continents (Fig. 8).

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Overvoltages Caused by Disconnect-Switch Operation

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A. R. HILEMAN
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RECENTLY field tests were performed at the Tanners Creek Station of the Indiana and Michigan Electric Company to investigate overvoltages which were produced when a 1,360-foot section of 345-kv bus was de-energized by an air-break disconnecting switch.[1] The high transient overvoltages not only caused severe duty on connected lightning arresters, but also induced surge voltages in the station low-voltage power and control circuits. In conjunction with the field investigations, analytical studies were initiated in an attempt to determine the causes of the overvoltages and to develop remedial measures which could be used to eliminate the overvoltages.

Initially, several simple systems or bus configurations were analyzed in an attempt to discover the type of circuit which produces the maximum voltage at the end of the bus. The simple system of Fig. 1 was found to produce the highest magnitude of overvoltages and is similar to the circuit at Tanners Creek. All of the bus sections and transmission lines are assumed to have the same surge impedance of $Z = 400$ ohms. A resistor having a resistance of Z/n ohms represents n connected transmission lines. L_2, L_3, and L_b are the lengths of the bus sections. The initial conditions before restriking across the switch occurs are that the voltage on the system side of the disconnect switch is equal to the 60-cycle line-to-neutral crest voltage magnitude or $+1.0$ per unit and that a voltage of -1.5 per unit is trapped on the isolated bus.

From this circuit, it is found that the bus voltage increases as n, the number of connected transmission lines, increases. For example, if $n = 2$, the bus voltage is 2.25 per unit and for $n = 6$, the bus voltage is 2.9 per unit. The maximum bus voltage occurs for $n =$ infinity and is equal to 3.5 per unit.

Several schemes of suppressing overvoltages were suggested but the most promising, practical scheme consisted of placing a resistor in series with the bus section being de-energized during operation of the disconnecting switch. An investigation was initiated to determine the necessary ohmic value of the resistor to suppress overvoltages. Because the maximum bus voltage exists for the condition of $n = \infty$, this circuit is used to determine the necessary ohmic value of the resistor to suppress overvoltages on the bus. Fig. 2 shows the relationship between the ohmic value of the resistor and the maximum bus voltages. As noted, the required ohmic value of the resistor depends on the ratio of L_2/L_b. That is, to limit the overvoltages to a constant magnitude, the ohmic value of resistor increases as L_2/L_b increases. If L_2/L_b is very large, it is theoretically impossible to eliminate overvoltages. However, it is not necessary to eliminate overvoltages completely. It

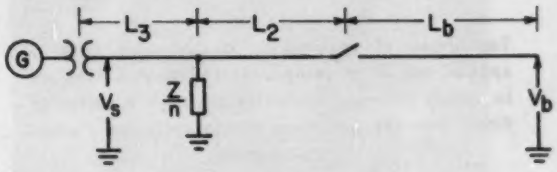

Fig. 1. General circuit used to investigate overvoltage on the bus and the effectiveness of series resistor.

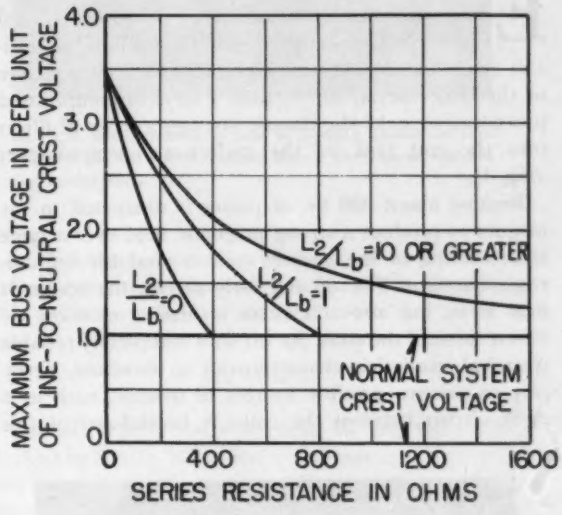

Fig. 2. Maximum voltage on bus, using a resistor in series with the switch ($n = \infty$ in Fig. 1).

is necessary only to decrease the magnitude of the overvoltage to a value below the arrester sparkover voltage. If the maximum voltage is limited to 1.3 to 1.4 per unit, the voltage is significantly below the arrester sparkover voltage, and dangerous induced voltage in the station power and control circuits should be reduced. Using this criterion, and assuming large values of L_2/L_b, the ohmic value of the resistor needed is 1,200 to 1,600 ohms.[2]

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S. B. Griscom, J. W. Skooglund, and A. R. Hileman are with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

Cooling Off a Cyclotron

W. F. GOODELL JR.

Technique of recharging a cyclotron with a special oil is a complicated 2-day procedure in which change is effected through a series of filters into the coil tank of the cyclotron's electromagnet.

EARLY in 1958, after more than 8 years of almost daily use, the 9,000 gallons of oil used to cool Columbia University's Nevis 400 million electron-volt synchro-cyclotron was replaced with a new charge of the same special oil. It took 2 days of complicated procedure to make the change through a series of filters into the coil tank of the cyclotron's electromagnet (Fig. 1).

Because about 600 kw of power is dissipated in the magnet to produce a strong magnetic field over a large area, cooling of the magnet coils is vital for uninterrupted service. The oil not only carries the resultant heat away, but also acts as an insulating medium between turns of the coils. An oil with completely reliable electrical insulation characteristics is, therefore, necessary to prevent possible sources of trouble, such as a short circuit between the coils. A breakdown of this type would take about 6 to 12 months to repair inasmuch as the cyclotron itself would have to be literally torn apart.

Fig. 1. Filling of the cyclotron oil system took place with the tank truck parked in main experimental area. Part of main concrete shielding wall of cyclotron was removed to permit access with the crane.

Because of the particular construction of the magnet, the electrical innards of the cyclotron would have to be ripped out, the vacuum chamber removed and parts of the main magnet disassembled (Fig. 2). To give some idea of what could happen with an inefficient oil, let us consider a drop in breakdown voltage causing an electrical short circuit between pancakes of the coil. The subsequent welding of the various copper pieces would require the magnet coils to be stripped of their cooling tanks.

Each coil tank is 25 feet in diameter, 4 feet high, and weighs 110 tons loaded. To get at them, the 30-ton vacuum chamber would have to be removed as well as four of the cyclotron's pole pieces, a total weight of 160 tons. Although the 2,000-ton magnet would not be disturbed, the shielding wall would have to be torn down. The bottom part of this wall is 8 feet thick, 50 feet long, 6 feet high and is made up of about 300 tons of pig iron around which concrete has been poured.

Roughly, it would take 20 men working full time for 6 months or more to get to the heart of the trouble. And the aggravating fact is that the trouble itself might take no more than 5 minutes of work to file off a bad connection. Time and much effort would be needed just to reach it. Also, the cyclotron is somewhat radioactive in the areas of pole tips, magnet steel, and vacuum chamber. This would limit the amount of time any one person could work in the area each week to avoid receiving more than the safe standard radiation dose.

The cost of such an undertaking is estimated to be in the neighborhood of one-half million dollars, to say nothing of the valuable research time lost while the cyclotron is down.

The absolute avoidance of a cyclotron failure was obviously the most important factor to be considered when the time came to select a cooling oil. This evaluation was extensive and the choice finally was Diala Oil AX (registered trade mark), an electrical insulating oil which possesses exceptionally high dielectric strength and low viscosity. Because of its low volatility, evaporation loss is sharply reduced and optimum stability is assured by means of its special oxidation inhibitor.

OIL CIRCULATION

THE OIL IS CIRCULATED throughout the magnet coils at the rate of 2,000 gpm, which is sufficient for cooling

W. F. Goodell, Jr., is assistant director Nevis Cyclotron Laboratories, Columbia University, Irvington, N. Y.

purposes. Much greater amounts of conventional oil with less thermal capacity would be required to obtain the same cooling rate. To hold down the oil temperature, the oil is cooled in heat exchangers by river water down to 40 F in the winter and 80 F in the summer. The oil is pumped (45-hp motor) to a labyrinth inside the coil tank of the magnet itself where it makes intimate contact with the edges of the magnet's copper windings.

This proximity is necessary to draw the heat out of the magnet and into the oil. Because the temperature of the magnet copper must be kept to an absolute minimum, no contact through any other type of insulating material can be tolerated.

Although maximum operating voltage of the magnet coils is comparatively low, between 300 and 400 volts, a malfunction of the power equipment supplying power to the magnet could conceivably generate tens of thousands of volts in the coils. The high dielectric strength of the oil has eliminated breakdowns that might have resulted from such a transient.

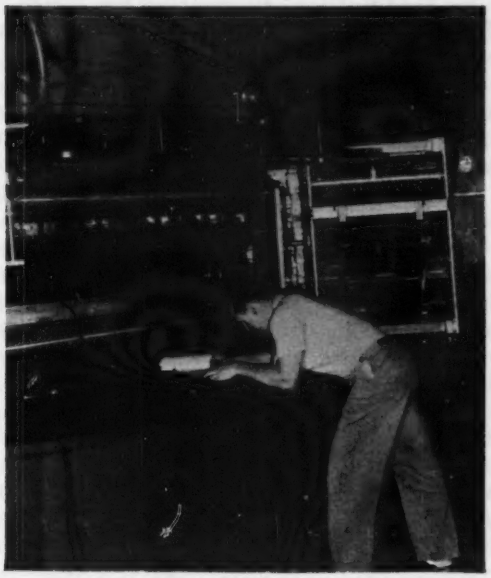

Fig. 2. Staff member records measurements inside open vacuum chamber of cyclotron, his data book resting on lower tank containing coil and oil. Units equipped with wheels are carbon lining of magnet pole tips. In background is quadrupole beam-focusing magnet.

All of the oil passes through a blotter press bypass filter (Fig. 3) to keep moisture content to an irreducible minimum and to remove contaminants such as the insulation between turns in the coils. Testing the oil's dielectric strength to make sure it has not been lowered is daily standard procedure.

Should the dielectric tester show any appreciable drop in dielectric breakdown voltage, the flow through the blotter press is increased. Ordinarily, unless there are leaks in the system, the dielectric voltage remains

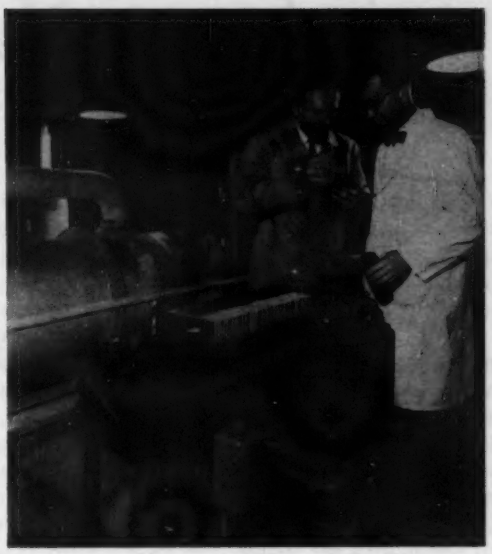

Fig. 3. A dielectric tester is used to measure breakdown voltage of Diala Oil AX. Oil blotter filter press removes moisture and contaminants.

at a satisfactory constant, well above 30 kv. A blanket of dry air is also maintained over the oil in the storage tank to further inhibit moisture intake.

OIL CHECK

ANNUALLY, over the 8 years of its use, the oil was checked by Shell's Wood River Laboratory for viscosity, flash point, dielectric, and saponification and neutralization numbers. The last analysis before the change showed that although the oil was still in usable condition, the saponification number had deteriorated somewhat. This was probably caused by the breakdown of varnishes and other organic materials in the windings of the magnet. It was the variation of the "sap" number and the negligible cost of new Diala Oil AX that prompted the decision to change the oil.

At first, recharging posed a problem. The staff wished to flush out the system, but the question was, with what? A standard flushing oil was suggested but turned down because no matter how thoroughly the system was cleaned, there was always the possibility that some of the flushing oil would remain to cut down the cooling oil's dielectric strength. The solution lay in using the original charge of oil as a flushing medium so that any remnants of the oil would be compatible with the new charge.

Temperature of the old oil was raised to 120 F and various valves opened to speed up the flow through the system. Following this, as much of the oil as possible was removed and the new charge inserted.

The personnel at Columbia University's Nevis Cyclotron Laboratories look forward to another 8 years of trouble-free cyclotron cooling.

SAGE Data Terminals

R. O. SOFFEL E. G. SPACK

IN THE SAGE SYSTEM, the function of converting the data in the form generated or used by the processing equipment to a form suitable for transmission over the communication channels is performed by the terminal apparatus of the Western Electric Company *A1* digital data signaling system. At the originating terminal, the data source furnishes three separate components of information, timing, data, and start, to the digital data transmitter (DDT).

The transmitter combines these into a single, three-valued signal which modulates a 2,000-cycle-per-second carrier. The amplitude-modulated signal is then applied to the communication channel as a vestigial side-band signal with the usable side band limited to approximately one half the bit rate (1,300 or 1,600 bits per second).

The function of recovering the transmitted information from the line signal and reproducing the timing, data, and start components is performed by the digital data receiver (DDR). A band-pass filter in the receiver provides the vestigial side-band shaping and also removes the out-of-band noise accumulated during transmission. The filtered signal is demodulated to recover the modulation envelope, which consists of a wave containing positive and negative peaks, representing the start and data pulses, respectively. These pulses are separated in proper sequence by the decoder section of the DDR. Inasmuch as the time duration and phasing of these pulses may be variable because of line noise and other irregularities, the start and data pulses are regenerated in the decoder. These regenerated pulses are then applied to a modulator where dipulses are produced. (A dipulse is one complete cycle of the timing wave per bit which, in telegraph terminology, represents a mark. Absence of a dipulse in the data component represents a space.)

Start pulses from the decoder section are also used to control the frequency and phase of a timing generator. The frequency of the oscillator in the timing generator must be easily varied to correct for both its own variations and the variations in the source timing. To permit pulling-in and locking, the variation in the frequency of the oscillator must not exceed $\pm 0.1\%$.

In order that these requirements could be met, a circuit was devised which combines a precision tuning fork oscillator and a variable *LC* oscillator. The output of the timing generator consists of timing spikes used for pulse regeneration and a sine wave used in the modulator section. By using the start and data pulses from the decoder to gate the timing wave, modulator produces dipulses which are faithful reproductions of the original signals from the data source. These dipulses and the timing wave are then applied to the data-using equipment.

Because the proper operation of the DDR circuit depends upon the demodulated line signal being held to a close tolerance, an automatic gain control system is used with the received line signal. Depending upon the word length, a range of input levels of 35 db for short words or 20 db for 326 bit words will cause a variation of only ± 0.1 db in the demodulated signal. The amount of sudden level change which will not cause errors in the DDR is a function of both the input level and the word length, and varies from 0.75 to 1.75 db. The maximum theoretical sudden level change which can be tolerated for the type of line signal employed is 1.8 db. The levels of thermal noise and impulse noise which will not cause the DDR to exceed its allowable error rate are also reasonably close to the theoretical maximum allowable values.

The DDT and DDR actually constitute only a part of the digital data terminals. An originating terminal for a dual facility, i.e., a circuit which, for reliability reasons, provides two communication channels, also has splitting pads for dividing the signals from the data source and jacks for testing and patching. Line signals from the DDT's pass through jacks in the output circuit before being applied to the communication channels. Either channel may be used as the working circuit, with the other as the standby.

In addition to the DDR's, the receiving terminal contains trouble detector circuits, which monitor the communication channel for excessive noise and the DDR for loss of the start output, and a transfer and control circuit which switches the circuit connected to the data-using equipment in response to trouble indications from the trouble detector.

Special test circuits, called the word generator and the matching and error counter, have been designed to test the data equipment. When used with a DDT, the word generator simulates the data source by producting start and data dipulses together with an accurate timing wave. Word length, data bit location and signal amplitude may be varied. At the receiving end of a data circuit, the matching and error counter provides means for accurately checking the data pulse by pulse. This test circuit matches the data output of the DDR with the output of a word generator located at the receiving terminal. Timing from the DDR is used to control the matching and error counter and the word generator at the receiving terminal.

Digest of paper 58-407, recommended by the AIEE Data Communication Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Pittsburgh, Pa., Oct. 26-31, 1958. Published in AIEE *Communication and Electronics*, Jan. 1959.

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Electrospherics and Magnetospherics

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In the second part of a two-part article, additional experiments with small spheres of magnetic material are described. Not only are the results interesting in themselves, but also it is hoped that they may serve as analogs for such phenomena as Brownian movement, thermal movement of molecules, crystal formation, bacterial chaining, and others.

Part II

MAGNETOSPHERICS AFLOAT

Floating Ball Techniques. The trick for building a shot raft of any size is to hold the size 50 balls in a plastic teaspoon. With half an inch or so of water in the ballroom bowl, and a field current of 3 amperes, the spoon is lowered slopingly to near the water surface. The balls are now active. They hop off and float individually, then move to join the others. A raft is thus formed. The raft rides in its own depression, held up by surface tension.

A major nuisance now develops. Floaters tend to wander to the meniscus at the water's edge, where the water bends down because of the unwettability of the plastic, and stay there. The cure is to use a paper collar, cut to form a bowl liner. The water wets the paper, bends upward at the edge, and makes the floaters stay out on the surface where they belong.

Sinking the Raft. A raft of any size will float when there is no field. But when the raft is large (say, half an inch across), the alternating field will sink it, and the process is most interesting. With gradual increase of field current, the raft bulges downward more and more, forming a dry pocket or cavity. Finally, the pocket suddenly pulls down so far that the raft edges meet, a bubble of air is entrapped, and the folded-up raft goes to the bottom, still grasping its bubble.

The Many-Rayed Star. Using unmagnetized or largely demagnetized shot, we may make a raft about 0.2 inch across of about 150 balls. Because the raft is in a plane normal to the field, the field will cause magnetic repulsion.

As the field is increased, a many-rayed star grows. At lower currents, the center is still solid. At higher and higher currents, the separation increases, until there is a field of individual balls spaced several diameters apart. If the current is lowered the balls again will collect. Here is an expanding and contracting universe that can be put through its beautiful performance any number of times.

Standing Waves. When the star is in a stronger field, resulting from a current of 6 amperes or more, the outer balls, especially, will display some movement caused by vibration. A weak display of standing waves can be observed.

With balls magnetized, there is a far stronger display of standing waves. If from one to several balls are used, different patterns of waves can be set up. This phenomenon may deserve consideration as a demonstration of standing-wave propagation.

Passive Floater Formations. Using unmagnetized balls, or those very weakly magnetized after demagnetizing at the end of the cycle of events described previously, floaters will show some interesting stable formations. On the one hand, a few balls tend to get together, all resting in the same depression of the water surface. On the other, a vertical magnetic field makes them hold each other apart by magnetic repulsion.

Stable formations of the passive type that have been repeatedly observed are shown in Fig. 9, (a) to (f). There is the pair (a); the trio (b) has the equilateral triangle formation. For the foursome (c) the square is unstable, and we invariably get the diamond. Five balls (d) might be expected to have four in a square, with fifth centered, but the balls will have none of it—they take the 2:3 formation shown. With six or seven balls (e) and (f), symmetry returns: the pentagon or hexagon, with ball at center. This is not the end of it, of course. With more balls, other combinations occur.

Active Floater Formations. Here, we get some truly fantastic behavior, and those with plenty to do had better

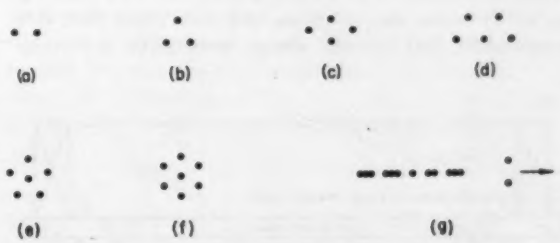

Fig. 9. Floating ball formations (a) to (f), with unmagnetized balls in passive stable formations. Magnetized balls (g), with active formation moving to right.

Part II of a two-part article, presented as a conference paper at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959, at a session sponsored by the AIEE Basic Sciences Committee.

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stay away from this show. It is done with magnetized balls. However, if the balls are too strongly or too weakly magnetized, best results are not achieved.

First, we recognize that there will be chaining. Two or more balls will tend to chain up, the north pole of one held to the south pole of the next. Second, such balls are vibrating, but not spinning. If they spun as synchronous motor rotors, they would become wet and sink. But with magnetic axes horizontal, the vertical alternating field is bound to make them vibrate, or oscillate. Thus, strong standing waves are set up, and there will be interaction between the balls and the fluid.

There is endless variety to the dynamic performance, and it is very difficult to describe it in detail. For example, half a dozen balls may aggregate, and rapidly whirl (rotate) in a fixed position. Chains near each other may remain stationary for some time, and then begin gyrating, or moving away together, or lining up with gaps between. When chains and singles get into rapid action, with ever-changing patterns and formations, it is difficult not to believe that here are living things, cavorting on the surface.

When degree of magnetization and field strength are just right, the most amazing performance will happen: an "organism" will form, and swim around. These "things" commonly have a backbone of several short chains, lined up but with gaps between, and with from one to many outriders—the whole organism busily swimming around here and there at a rapid pace.

The most stable active organism so far observed is shown in Fig. 9 (g). Almost straight, it swam around the coils' magnetic axis at roughly an inch radius, in a rough circle, for minutes on end. These things have to be seen to be believed.

Vibration-Induced Movement. These movements of active floaters are not (be it noted again) in any degree caused by rotation. Vibration or oscillation of balls is the only primary motivating principle. The balls affect each other; they interact with the water surface and produce forces; and, no doubt, the standing waves react on the balls in some manner.

At any rate, and in ways unexplained at this time, vibration or oscillation leads to propulsion.

MAGNETOSPHERICS AT THE RACE TRACK

One-Coil Race Track. From watching the ball ballet, where balls seemed to be doing their best to run along as synchronous motor rotors, the idea came that if a magnetized ball bearing sphere were given a smooth track and a proper driving field, it would perform smoothly. It did.

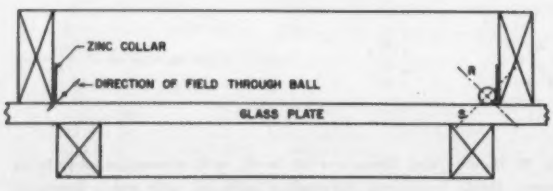


Fig. 10. The race track.

Fig. 11. The race track, with four balls placed on the track.

The first experimental coil was much like the upper coil of Fig. 3. It rested on a glass plate, with a zinc ribbon liner fitted inside of it to give the ball a smooth wall to roll against. A ball was magnetized, put on the track, started with a flip of the finger, and there it went.

There were troubles, however. The operating range of alternating current for successful performance was very narrow. At not much increase over minimum current, the ball became erratic, or would even start to climb the wall. The climbing tendency resulted from the fact that a magnetic body tends to move to where the field is stronger; and next to the wall, the field of the single coil is stronger at its center plane than farther down. Also, it seemed that for best operation, the field through the ball should be inclined at 45 degrees. All this experience called for a redesign.

Two-Coil Track. The two-coil design adopted is that already described, and shown throughout this article. It was originated for race-track purposes; and then, nicely enough, it was found to be completely adapted to producing a good field for the ball ballet and related phenomena. For the ball ballet, the coils are spaced widely apart, and are additive. For the race track, they are brought closely as in Fig. 10, and made to buck each other along the common axis.

The race-track coils are, however, additive where the ball is, and an exploration showed that the field direction there is at about 45 degrees to horizontal. In addition, the wall-climbing tendency is eliminated.

The Wall. Good performance calls for a smooth wall. This problem was finally solved by making a double-band collar of zinc ribbon (also called zinc tape). This material is half an inch wide, and 0.016 inch thick. The bands have butt joints, with the joints coming at opposite ends of a diameter. There is a strip of paper between, this first being painted with Glyptal varnish to make the bands stick together. The outer band's joint is covered with adhesive tape. The collar is inside the upper coil (Fig. 11).

Balls, and Ball Magnetization. The first balls to enjoy a spin around the track were ⅛-inch ball bearing spheres with no pedigrees, bought at a bicycle shop.

These were replaced by steel balls, Commercial A grade, ⅛ inch, kindly supplied by the Hoover Ball & Bearing Company, Ann Arbor, Mich. They were magnetized by using the two alnico magnets shown at the right in Fig. 11. One magnet was held in a vise, with the other clinging to it. To magnetize a ball, the upper magnet was tilted to open a gap, a ball was placed in the gap, and the magnet was allowed to close on the ball. Stronger alternating fields of the race track sometimes weaken the magnetization of these steel balls which then must be remagnetized.

Why a Ball Operates. Imagine a perfect ball in a vacuum, placed on a horizontal plane. The ball is magnetized. Its field is much like the earth's field, as is easily determined by use of iron filings. It has a magnetic axis. The axis is now randomly oriented in any direction with respect to the plane.

Next, let a uniform vertical sine-wave alternating magnetic field be set up, reaching to infinity in all directions. If the magnetic axis has any direction except vertical, there will be a varying torque produced, which has a net value greater than zero. The ball will start to accelerate, rolling on the intersection of a vertical plane with the horizonal plane. This vertical plane contains the line of the magnetic axis. If losses are negligible, it would continue to accelerate until it is spinning at synchronous speed and is producing zero torque. In the final state, the magnetic axis would be vertical when the field strength goes through maximum.

If friction and windage losses are made appreciable, as in a real situation, and we start over again, acceleration occurs and the ball again attains synchronous speed, but with the magnetic axis lagging enough behind its above positions to enable the ball to produce torque enough to drive itself along. These matters may be visualized more clearly if we replace the ball's actual field with the field of an appropriate magnetic dipole embedded in a sphere made of nonmagnetic material.

It was just stated that acceleration to synchronism would occur even with losses present. But this can depend on size. As we consider larger and larger balls, analysis shows that the moment of inertia rises faster than net torque at standstill for given values of field strength and ball magnetization. In practice, then, balls too large will, at a given frequency, not accelerate; rather, they sit still and vibrate. In order to get them into action, the frequency should be lowered.

Steel balls of sizes ⅛ to ⅜ inch, inclusive, are not self-starting on the writer's race track, but they all can be made to run, if given a start, at 60 cycles. The writer has never been able to make a half-inch ball run at 60 cycles.

The first person to get a half-inch ball into action was D. J. Provine, one of the writer's students, who had the misfortune of becoming so deeply interested in these new things that he spent the entire week of his spring vacation on them. With his own track, and using an audio oscillator he had already built, he made half-inch balls operate in the 10- to 40-cycle range of frequencies.

Torque Produced. Again think of a magnetized ball rolling on a horizontal plane, driven by a uniform vertical alternating field. Again, let the ball's field be considered as resulting from an embedded dipole. The instantaneous torque will vary. Average torque for a revolution will be maximum if the dipole axis is horizontal when the field is maximum. The torque argument that follows is for the maximum average torque condition.

It will be obvious that the forces on the poles of the dipole will be proportional to field strength times pole strength, and that torque will be proportional to force times lever arm. Inasmuch as the magnetic moment of a dipole is the product of pole strength times pole separation, the foregoing statement can be recast in these terms: Maximum average torque of a ball is proportional to field strength times magnetic moment. This is a general statement, true irrespective of the size of the ball.

How the Ball Runs the Course. Referring to Fig. 10, think of what happens if there is no field on, and the ball is simply started with a flip of the finger. In rolling around several times, its spin axis *S* would have to be inclined as shown. The ball makes contact at two points, with floor and wall. The two contact circles would have to have equal diameters if there is friction at both surfaces and if we consider track radius to be large compared with ball radius. Otherwise, there would be slip at one or the other of the contacts, or both. Thus, the spin axis would be inclined at 45 degrees.

Now let the driving field be turned on. If the ball is placed in at random and started up, the magnetic axis at first will have no particular orientation. But if the ball "catches on" and runs, there is a strong presumption (not yet rigorously proved) that soon the magnetic axis *R* will be as shown in Fig. 10, turning in a plane normal to the spin axis *S*.

If so, the linear speed of the ball center around the track is easily computed, in terms of synchronous rpm of the ball, and diameter of the contact circles. Actual tests of ⅛-inch balls check the prediction to within 2 per cent or better. This is strong verification for the previously mentioned presumption.

The ball will, of course, run equally well either way around the race track. Together with the coils, it constitutes a synchronous motor, and it might lay claim to being the world's simplest synchronous motor.

The Operating Range. Five Commercial A ⅛-inch balls were tested to determine the coil-current range within which normal track behavior takes place. The minimum current, below which the ball would stop, averaged 0.33 ampere—the highest and lowest values being 0.44 and 0.25. The maximum current, above which erratic behavior sets in, averaged 18.4 amperes—

the highest and lowest being 20 and 17. The operating range, then, was between 0.33 and 18.4 amperes. The range ratio was 18.4/0.33, or 56.

More Balls on the Track, and the Space-Apart Phenomenon. It takes more than one horse to make a race. Likewise, when a dozen or 15 balls are endlessly thundering around the track, they give an impression of honest effort seldom witnessed elsewhere.

One way to get two balls into action is to start one ball, place the second on the track, and let the first running ball kick it ahead. It will not kick it ahead until coil current is brought up to about 2.5 amperes. It is interesting to note that this is 7.5 times the minimum current, and that the square root of 56 (the range ratio) is also about 7.5. The meaning of this is certainly obscure.

With two balls in action, they will kick a third ahead, and so on. Thus, the running parade can be started. Another way to start the parade is to pour in a lot of balls, turn on a favorable current, sweep most of the mass ahead with the finger, and have them all go into action at once.

When a mass start is made, almost any spacings may occur at first. But soon, slipping occurs. Groups of balls will begin to close up their spacings; or, all of them may begin to close up the formation. It will seem that they are bound to run closer and closer until they rub, and perhaps stop the race. But then, a new thing enters in. When they get to be two or three diameters apart (see the four balls on the track, Fig. 11) they cease the approach, and run thus, spaced apart. Were it not for this space-out phenomenon, we could not have a continued race. What is its explanation?

Explanation of the Spaced Race. First, the tendency of two or more balls to approach must be taken up. These balls are all synchronized with the field, and with each other. Any two balls running close together have their magnetic axes parallel at all times. If we replace a ball's field with dipoles, and analyze the varying forces between two rotating, synchronized dipoles, we find that the force between them varies through plus and minus values, but that there is a net force of attraction taken over the whole cycle. Hence, two balls, near each other, will tend to slip and come closer together.

Since they do not come together, some other force must hold them apart. And this, of course, is magnetic repulsion. It is easily demonstrated. If two unmagnetized steel balls are placed together on the track, they will move apart when the coil current is turned on. Or, if two magnetized balls are placed on the track and allowed to stick together, turning on a sufficient current will make them come apart and separate.

The running balls, then, if too far apart, will draw together until a balance is reached between the attraction and the repulsion force. If too close together, they will separate to that same spacing.

It was magnetic repulsion, as witnessed at the race track, that furnished the stimulus to dream up the ball crystals later to be described.

The Steeplechase. Cut out a square of paper, an inch or so each way. Trim one edge rounded, to fit the wall of the race track. Place it on the floor, slide it over to the wall, and let the racing balls run over it. Then, with thumb and finger, press down on the ends, and slide them a little towards each other to bulge the center upward about a quarter of an inch. The balls will take the hurdle, and add to the merriment.

Inclined Race Track. These balls willingly climb a slope, as demonstrated when the entire track assembly is tilted. When tilted until a ball can barely make it on the upgrade, it is obvious that the ball continues to spin synchronously, but slips and decelerates. The winning hill-climber was not defeated until a tilt of 16 degrees was reached.

Measurement of Magnetic Moment of a Sphere. If there is now no convenient way for measuring the magnetic moment of a sphere, a modified race track might offer a method. There would be a smoothly accurate track of large diameter, with the V groove opening upward. Drive coils would be designed to give a uniform vertical field. Resistance to the ball's movement would be almost all caused by air resistance, which can be found by experimentation. In fact, the writer has already experimented with balls rolling down an inclined groove under water. A very good dimensionless correlation between drag coefficient and Reynolds number was obtained for considerable ranges of ball diameter and track inclination.

In measuring magnetic moment, the minimum current that would just barely keep the ball going at full track speed would always be determined. The ball then would always be so synchronized that its magnetic axis would be horizontal when field strength was maximum. For larger balls, lower frequencies could be used. By using the above correlation curve together with the known properties of air, ball velocity, and cross-sectional area, the drag would become known. Thus, the torque would be determined, and, from this and the known field strength, magnetic moment could be computed.

Ball Force Measured. Only two direct measurements have been made. A ¼-inch alnico ball, magnetized, was placed on the writer's race track. It had a minimum operating current of 0.5 ampere. It was allowed to run against the end of a Mylar (registered trade mark) strip, deflect it, and continue to deflect it by standing there pushing against the Mylar while spinning at synchronous speed. The strip deflections were later reproduced by weights.

At coil current of 3.5 amperes, the force was about 150 milligrams; at 7 amperes, about 300 milligrams.

Erratic Behavior. When coil current is raised above the top of the operating range, a ball's behavior becomes erratic. It may run "steady by jerks," but continue going the same way. It may occasionally reverse, or even cut across the floor.

Oscillation. As coil current is gradually increased above the operating range, erratic behavior sets in. With further increase, erratic behavior usually continues, but occasionally the ball begins to oscillate. Time and again, oscillation was observed, but at first it could never be induced at will.

Eventually, it was found that reliable oscillations can be produced. First, the glass plate between coils is removed, and replaced by a much thinner plate of plastic or aluminum. An aluminum plate 0.05 inch thick works very well. Second, a ¼-inch alnico ball is used, with coil current of from 3 to 10 amperes. The ball smoothly oscillates back and forth along the track, over a space range of 1 to 6 inches.

The factors involved are highly speculative. The shape of the field through the ball is such that the field pulls the ball into the groove; and the greater the field strength, the greater the pull. High contact forces may mean high friction forces. In some complex way, these forces, coupled with the ball's spin, may bring in gyroscopic effect and cause the spin axis to precess. Thus, as the ball reaches the middle of its travel, the ball may begin to turn over, with friction at contacts putting on the brakes to bring it to a standstill; whereupon, it reverses its travel and goes through the whole thing again during the other half of the oscillating range.

It is to be hoped that someone will approach this problem with adequate experimental techniques and theoretical analysis. Could it be that this phenomenon might serve as a rough analog for some other situation, such as magnetic resonance?

Alnico Balls on the Race Track. It was predicted that alnico balls, much more strongly magnetized than the steel balls, should run the truck at much lower coil currents. Industrial Tectonics, Inc., of Ann Arbor, kindly made up and supplied two special samples of alnico balls, ⅛ and ¼ inch in size. They came already magnetized.

The first trial of a ball was made with high anticipation, but the ungrateful little thing responded with dismal failure—nothing but erratic behavior. Then it was realized that the current used was too high. Alnico balls have their own operating range.

Tests on seven ⅛-inch ball gave an average minimum operating current of 0.03 ampere and an average maximum of 1.8 amperes. The operating range ratio is 60, average value. It is rewarding to find how closely this compares with the operating range ratio of 56 for the steel balls, despite the fact that the currents are far different.

Comparing maximum currents, 1.8 for alnico and 18.4 for steel, the ratio here is about 10:1. It is a good presumption that the magnetic moment for these alnico balls is about 10 times that of the steel balls.

The larger the ball, the narrower its operating range, at 60 cycles. Five ¼-inch alnico balls averaged 0.54 and 1.2 amperes for minimum and maximum currents, the ratio being only 2.2. Three steel balls of the same size gave about 4 amperes minimum, 20 maximum, and an operating range ratio of 5.

The ⅛-inch alnico balls can be made to run the course, two or more, spaced apart, at currents high in the operating range. But in the low part of the range, magnetic attraction predominates over the repulsion coming from a weak field, and the balls will bump each other, and go into a state of confusion.

Subnormal Track Speeds. Steel balls run the track in normal fashion, or else become erratic at currents above the operating range. But on a very few occasions, above the range, balls were found going for a little while at subnormal track speeds. At first, the guess was made that the ball had chosen to spin at a submultiple of synchronous rpm; and this still might happen at times. Many efforts to induce subnormal speeds ended in failure, until a ¼-inch alnico ball was tried, together with an aluminum sheet (0.05 inch thick) for a floor and coil separator, used in place of the glass plate.

This ball had a normal track speed of 114 rpm, at coil current of 0.5 ampere. At higher currents, it consented to run at subnormal speeds instead of oscillating. The data will be given in pairs, the first figure being current and the second, rpm around the track: 2.5, 24.9; 3.0, 40.6; 3.15, 43.8; 3.7, 57.5; 4.4, 65.0. Normally, one would present the data in tabular form, and also plotted. The curve is indeed fairly smooth. One hesitates to dignify the data with such treatment, because at 1 ampere, the track rpm jumped to 86!

This thing is full of unknowns, and further investigation is needed.

Pandemonium. If one or two dozen ⅛-inch alnico balls are placed in the track, and a current of 3 or more amperes (above the operating range) is used, pandemonium ensues. The balls frantically run in all directions, bump each other, and rebound.

Climbing the Prison Wall. This piece of drama was discovered quite by accident. Using only the upper coil, 150 or so ⅛-inch steel balls, unmagnetized, are poured onto the floor of the race track. They are prisoners, aimlessly standing around in the prison yard. But they await only the "signal," to make a break for liberty. The signal is the very sudden turning on of a high current—about 10 or 15 amperes. There is a mad stampede for the wall. Faster than the eye can see. the prisoners stack up, as in Fig. 12. If the current is suddenly cut off, the prisoners fall down, run out into the open, and collide all over the place with much noise. The prison break can be repeated time and again, but no one ever escapes.

MAGNETOSPHERICS: CRYSTALS

Dendritic Crystals. The little "trees" described in the cycle of events and seen in Fig. 6 are shaped like pine trees. Branching or tree-like crystals are called dendritic. The sparse young forest growth of Fig. 6 can be

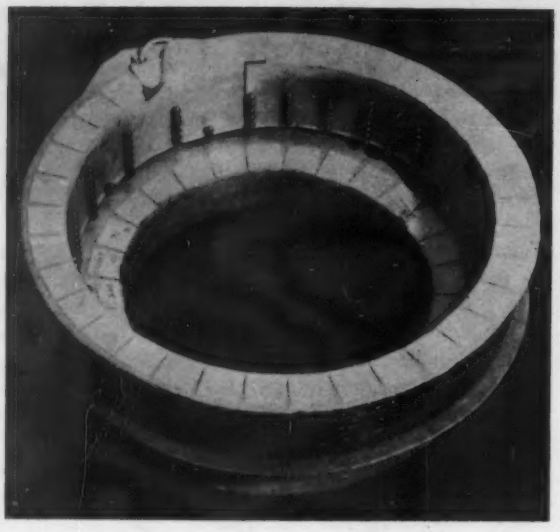


Fig. 12. Balls stacked up the wall by strong field of upper coil only.

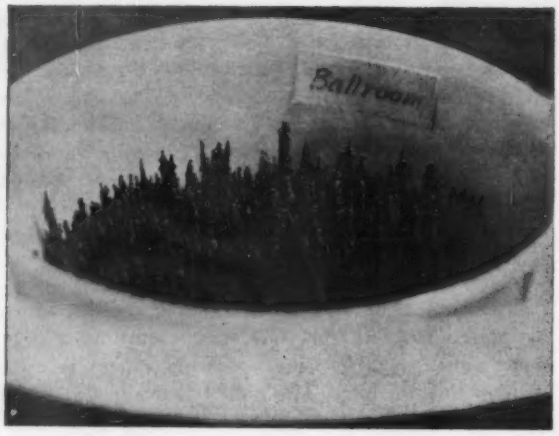


Fig. 13. Dendritic crystal formation of cast-iron shot in an alternating magnetic field.

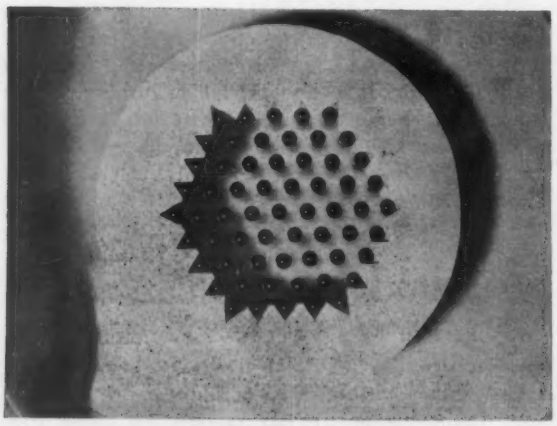


Fig. 14. A 4-shell ball crystal of 61 balls.

turned into a thick forest (Fig. 13) by pouring a quantity of cast-iron shot into the ballroom bowl while the bowl is sitting on the plate, and with the coils arranged and connected as for the ball ballet.

When hard shot are slowly poured into the bowl with about 8 amperes flowing, a beautiful spectacle develops. The growing mass of shot takes on, and maintains, a rounded mound shape, being covered densely with little pine trees which move slowly outward as the shot is poured. At around 14 amperes, the trees are much higher and slimmer, as seen in Fig. 13.

Very long, needle-like dendritic formations occur when the shot are allowed to grow in a more nearly rectilinear field. When a hollow solenoid is used, about 4 inches long and about 2 inches in diameter, and placed upright, great long strings of crystals can be formed. The same general effects occur at lower currents when malleabilized cast-iron shot is used.

Ball Crystals. Spheres of equal size that are allowed to form a monolayer of closest packing will assume the hexagonal formation. Earlier experience with magnetospherics, in which magnetic repulsion made the balls space away from each other, brought on the idea that if proper boundaries were furnished, repulsion might make a set number of balls space themselves apart and take hexagonal form. This application of magnetospherics came through with spectacular success. In Fig. 14, 61 unmagnetized ⅛-inch steel balls have formed a "ball crystal." There are four shells around the center ball. The count, starting with the center, is 1:6:12:18:24.

The complete set-up is shown in Fig. 3, where pieces of rubber sheet with notched hexagonal opening are seen at the left. The ballroom bowl is shown there in the coil assembly. Remove this, place the rubber boundary piece at center on the plate, pour in the 61 balls, and suddenly turn on about 10 amperes. No matter where the balls may have been, they rush to positions, and form the crystal.

A larger crystal was, of course, an imperative, and Fig. 15 shows a ball crystal of 7 shells, 169 balls. Turning on about 15 amperes will form this crystal. Even if all notches are emptied, and the balls are deliberately massed anywhere at will with current off, the onset of the alternating field gives them the repulsive forces that promptly result in the orderly array. Of all these magnetospheric phenomena, the ball crystal is perhaps the most arresting.

If the inner edges of the rubber boundary are left smooth, repulsion forces will crowd an excess number of balls into the outer shell—hence the need for notching.

Ball Crystal Defects. Let a ball crystal be formed, and held by maintaining the field. If a ball is picked out, there will be local readjustments where the defect appears, but the major pattern elsewhere is retained, or one or more balls may be added. There will be defects, but the hexagonal pattern does a brave job of forming where it can.

Grain Boundaries Shown in Ball Crystals. Grain boundary phenomena are of major interest nowadays, and something of their nature may be seen in terms of ball crystals. In Fig. 16, the lower three sides of the opening belong to one hexagon, while the upper two sides belong to a differently oriented hexagon. A lot of balls were poured in, and the results are as might be expected. The two crystals growing out from the two different boundaries disagree, come to a compromise, and show defects and grain boundaries.

These ball crystals need further investigation. Using notched sides, smaller balls, and many more of them, the grain boundaries might show up much more clearly. New light might be cast on actual crystal phenomena.

Waves and Eddies in Ball Crystals. Consider the ball crystal in Fig. 15. There are elastic forces between balls, and the balls have mass. Therefore, wave phenomena should be capable of demonstration.

If a pencil is used to give the rubber boundary a sudden short push sidewise, a wave travels across the crystal, and is reflected from the other side. Moreover, a striking effect comes of stirring the balls with a paddle. The balls flow around the paddle, and form eddies behind it. The effect is so convincing that it is difficult not to think that one is stirring a liquid.

CONCLUSIONS

Electrospherics. Several static and dynamic electrospheric phenomena have been discovered and described, in which metallic spheres, electrified by rolling contact with a dielectric surface, are attracted by the surface but are mutually repellent. The several behaviors are interesting in their own right; and some may at least roughly serve as visual demonstrations of other phenomena such as crystal formation, electrons attempting to leave a cathode, molecular movement, Brownian movement, and so on.

Magnetospherics.

1. The simple equipment for demonstrating magnetospheric phenomena has been described.

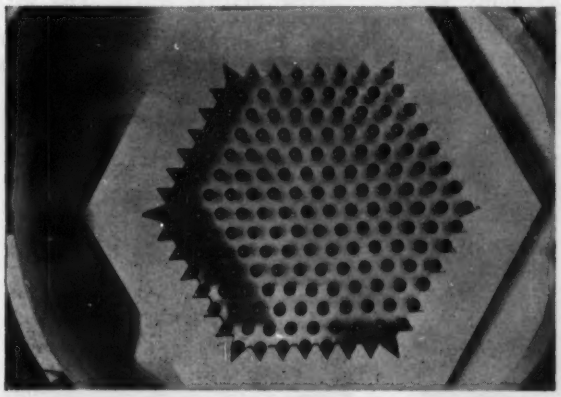


Fig. 15. A 7-shell ball crystal of 169 balls.

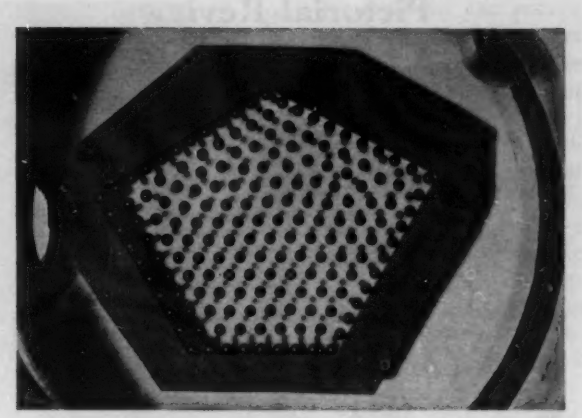


Fig. 16. Grain boundary phenomena. With parts of mismatched hexagons for boundaries, two crystals attempt to grow, and have to reach a compromise.

2. In the ball ballet, anywhere from one to thousands of tiny magnetized balls in a plastic bowl are made to dance, under the influence of an alternating magnetic field.

3. The ball ballet, with the aid of electrospherics, becomes an eddying, streaming, or circulating phenomenon, with properties simulating those of a liquid.

4. The balls are shown to be acting as synchronous motor rotors.

5. At low field strengths, the ball ballet is turned into various chained-up configurations in which one might seem to see bacterial chaining and the growth and tearing down of crystals.

6. At high field strengths, the balls form dendritic "crystals."

7. The ball ballet can take place under water.

8. Techniques have been worked out for floating unmagnetized and magnetized balls on water, in static and dynamic formations. Standing waves appear. Formations of balls, some in contact and some not, can swim around under their own power. The mobility of these "organisms" derives entirely from vibration, not from ball rotation.

9. From one to many steel or alnico balls will run a circular race track. A ball on the track can be made to oscillate.

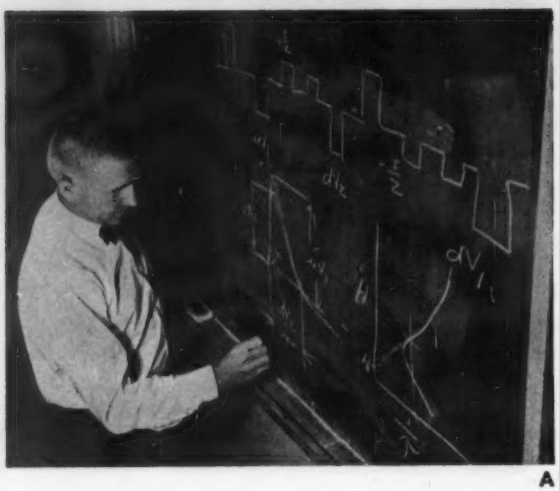
10. The race track, properly modified, might be turned into a simple method for measuring the magnetic moment of a magnetized sphere.

11. Large numbers of balls in any chaotic array can be snapped into the perfectly ordered form of the hexagonal ball crystal merely by turning on the field. The ball crystal seems to offer possibilities for studying crystal defects and grain boundary phenomena.

12. Undoubtedly, still other electrospheric and magnetospheric phenomena remain to be discovered and devised. Those discovered so far are endlessly fascinating. Some are readily understood. With others, much effort will be required before they can be fully explained.

Pictorial Review

Magnetic Memory Element Exhibits 4-Millimicrosecond Switching Speed



A

FUTURE electronic computers will "think" at speeds 10 and 20 times faster than now by using a magnetic pin-sized device, thus enabling new missile and satellite advances. This device, a glass rod with a magnetic coating (**B**), serves as both a switching and information storage element. Top speed of the magnetic element is as yet unknown. But research models (**D**) showed switching characteristics as fast as 4 millimicroseconds.

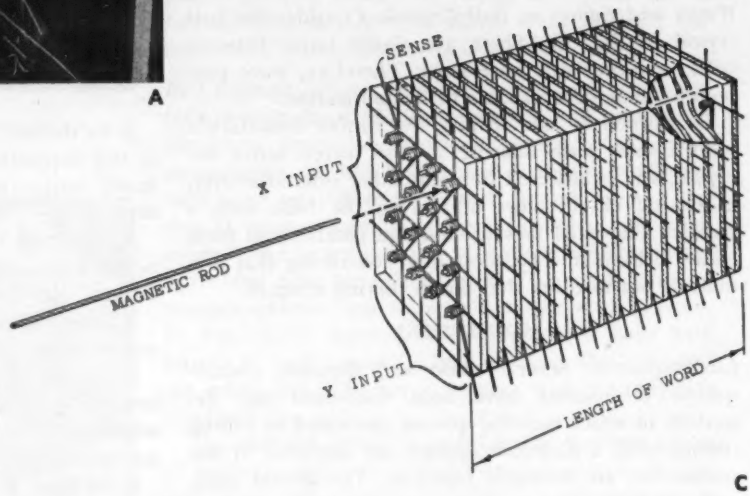
The new component (**E**) was developed under the direction of D. A. Meier, research scientist at The National Cash Register Company's (NCR) Electronics Division, Los Angeles, Calif., who explained the rod construction and its switching characteristics in detail (**A**) at the AIEE Conference on Magnetism and Magnetic Materials.

The rod was described as "one of the most significant recent advances in digital-computer technology," by R. G. Chollar, NCR research vice-president. He said that thousands of the rods could be linked electrically within a small space to solve problems with "unprecedented speed." The rod element can be used both in word-ordered and coincident-current (**C**) memory circuits. In contrast with present-day memory units which are costly to less-expensive mass production techniques, both in fabrication and testing.

B

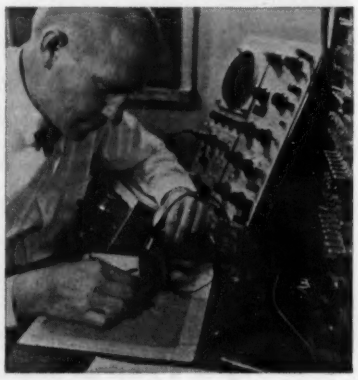
Only 20 thousandths of a watt is required to store a "bit" of information on a rod. Energy needed to light a 100-watt bulb could operate 5,000 rods simultaneously.

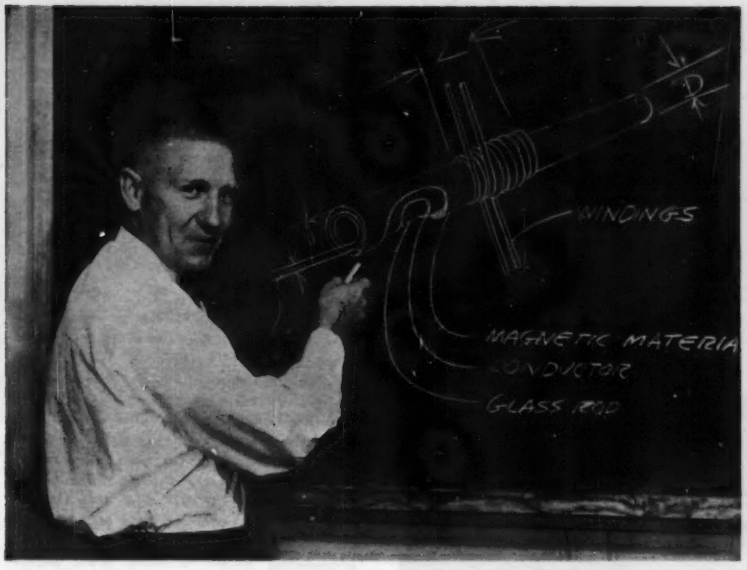
The rod will make it possible to navigate a missile or satellite with smaller power sources and increase the useful range of these vehicles. The new component will also enable missile and space vehicles to navigate more dependably in the extremely high temperatures encountered during flight. The magnetic rod operates reliably at temperatures 300 F higher than conventional components. In the laboratory, the rod has been switched continuously at a 5-mc repetition rate without adverse heating effects. The hys-



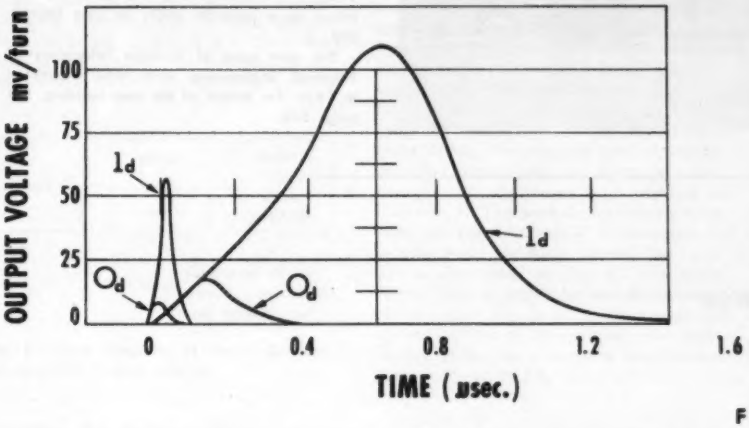
C

D





E



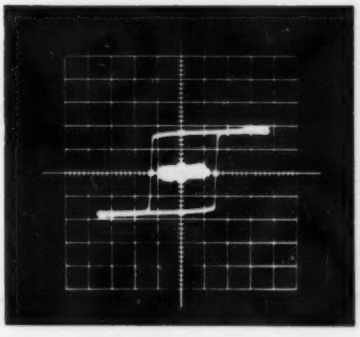
F

teresis loop (**G**) on the rod's magnetic coating is extremely square. Ratios of better than 0.95, when inserted (**H**) into a Helmholtz coil, are shown on an oscilloscope.

The magnetic memory element also is expected to find many applications in commercial data-processing. By handling information much faster than existing switching and memory units, it was stated, rod networks will reduce the amount of equipment needed to handle the problem. Comparison (**F**) of switching speeds of the new magnetic rod and a 1-microsecond ferrite core shows the rod to be 20 times faster.

Inasmuch as the rod can serve both as a logical switch and as a storage element, it permits a reduction in the number of semiconductors required in a computer. As a result, the number of active components in a computer can be reduced, improving reliability.

G



Space requirements for storage of information are cut by compact rod size. Thus, a cigarette-package sized rod memory system could store 8,000 bits of information.

It is possible to wind 10 bit positions per linear inch along the rod without mutual interference. These windings (**E**) of very fine wire are placed on the rod in a solenoid-like manner with successive windings superimposed. At present, packing density is 1,000 bits per cubic inch.

A single magnetic element for a coincident-current memory requiring two inputs, an inhibit winding, and a sense winding would consist of four separate single-layer concentric solenoids over the rod.

H

Memory matrices can be stacked and simultaneously threaded.

The rod, about 15 thousanths of an inch in diameter (**B**), is given a magnetic coating by an electrochemical process developed by NCR. The length of rod can be varied as needed, depending upon the storage capacity desired. Small windings of wire around the rod store the information (**C** and **E**).

Typical applications of the rod now being investigated at the NCR Electronics Division are (1) a high-speed memory with 1-microsecond cycle time, (2) shift registers and counters which work in the range of 2 to 5 mc, and (3) multipropositional logical applications. Using a system of inhibit logic, a laboratory switching model of the rod handles as many as 30 different propositions.

ELECTRICAL ENGINEERING EDUCATION

AIEE in Yale University

THE AIEE STUDENT BRANCH at Yale University, New Haven, Conn., was started on October 13, 1911, by Prof. C. F. Scott, who founded the system of student branches when he was president of AIEE during 1902-03. Until the Connecticut Section of the AIEE was established in 1921, the Yale Branch served as a meeting place for both students and practicing engineers in the area. The present Branch Counselor is Prof. J. C. May (M '51).

Engineering began at Yale in 1852 with the establishment of a professorship in civil engineering. In the following years, departments for other branches of engineering were added to the Sheffield Scientific School. In 1932, the School of Engineering was established as a separate entity in Yale University.

The new wing of Dunham Laboratory of Electrical Engineering (left) was completed in 1958. For details of the new building, see page 242.

An Electronic Random Number Generator

J. A. LAUDER
STUDENT MEMBER AIEE

THIS ARTICLE DISCUSSES the generation of random numbers for use in auditory psychophysical experiments conducted at the University of Michigan's Electronic Defense Group laboratories. These experiments, which require randomized signal presentation, are designed to test theoretical hypotheses related to the operation of the human auditory mechanism.

Random numbers are used in selecting safe combinations, for the random sampling of industrial products for quality control checks, and in conducting various types of psychophysical experiments. Random numbers are defined, for purposes of this paper, as a set of numbers with no patterning or exact predictability. Random numbers can be selected in many ways, such as using dice, random number tables, by pulling numbers out of a hat, or by stopping a spinning disk randomly.

In a typical psychophysical auditory test, observers are instructed to listen for a pulsed sine wave generated by an audio oscillator. The signal, masked by a background of white Gaussian noise, occurs in one of two possible time intervals. The observers indicate, by pushing a button, their selection of the interval that contains the signal. If the sequence of signal presentations were patterned, then the observers could learn the pattern and would not have to detect the signal to determine the interval in which the signal occurred. On the other hand, if the sequence of the signal presentations is programmed by a random number selection device so that there is no discernable pattern, then the observers must detect the signal to give a correct answer. In this case, the experimenter can feel confident that the percentage of correct answers reflects the observer's detection capability rather than his ability to learn patterned sequences.

The major problem, dictated by the requirements of these experiments, is to design a unit that will select a random number at least once every second, and make it available to the programming equipment. The unit being used at the University of Michigan meets these requirements.

This article will describe the operational characteristics of this unit, referred to as a "radiation delay electronic spinning disk random selector," and the basic design theory. The method of approach will be first to describe a basic electronic spinning disk random selector, and then to discuss the theory of randomness of the spinning disk principle. This theory will then be put to use in describing a subunit of the main random selector. Finally, the complete radiation delay electronic spinning disk random selector will be explained.

Basic Electronic Spinning Disk Random Selector

The essential part of the electronic spinning disk random selector is a multiposition glow transfer tube (counter tube), which can be driven by an oscillator. By driving the counter tube at a constant rate

Full text of the paper awarded first prize in the AIEE District 5 Student Prize Paper Competition. Recommended for publication by the AIEE Educational Publications Committee.

J. A. Lauder is a student at the University of Michigan, Ann Arbor, Mich.

Fig. 1. A basic electronic spinning disk random selector.

and stopping it at randomly spaced time intervals, a sequence of random positions of the glow spot is obtained. If these glow positions are numbered, say from 1 to 10, then selections of random numbers between 1 and 10 can be obtained. A basic electronic spinning disk random selector is shown in Fig. 1. Fig. 2 is a block diagram of the random selector showing the counter tube (which also serves as a visual

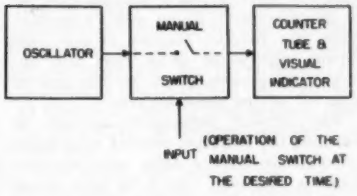


Fig. 2. Block diagram of basic electronic spinning disk random selector.

indicator), the driving oscillator, and a manual switch to interrupt the pulses to the counter tube, thus establishing the selection. Randomness is obtained by operating the counter tube at a relatively high rate with respect to the period between operations of the switch. Any device that operates the switch will have some variance in its timing. If this variance is large enough with respect to the period for one cycle of the counter tube, then independence of number selections is obtained. When the switch is closed, the counter tube looks and acts like a disk spinning about its center. This is the reason for classifying this device as an electronic spinning disk.

Theory of Operation

Now that the basic electronic spinning disk random selector has been presented, the next phase to consider is the randomness of the selector. Assume the counter to have a modulus of 10 (i.e., 10 unique stable states), and a period t between input pulses. One modulus cycle then has a period of $10t$ or T, and, in this case, is the time for one revolution on the counter tube. The counter must pass through each of its 10 states for every modulus cycle. Since the input pulses are equally spaced, the counter will spend an equal amount of time in each of its 10 states. If the counter is recurrently stopped in such a way that the stopping time is uniformly distributed over the modulus cycle, then the probability of a number being selected is equal to the fraction of time the counter stays on the number. In this case, there are 10 possible states, so the probability of a certain number occurring is 0.10. If the selection time is random, and the probability density of the selection time is uniformly distributed over the modulus period T, then the numbers selected will be random and equally-likely. If successive selection times are independent, then successive numbers will be independent, with no patterning. Thus, the mechanism which is to operate the switch and make the random selections must have an independent selection time, and must also provide a uniform probability density function over the modulus cycle T.

Assume that a device is available which delays an input pulse a random period of time, and assume also that it provides a delay probability density function which can be approximated by a normal distribution curve as shown in Fig. 3. The probability density function of Fig. 3 does not begin to approximate a uniform function, but the desired uniform function is only over the modulus T. If the distribution curve of Fig. 3 is wrapped around a cylinder of circumference T, then, in effect, the curve is segmented into intervals of duration T. The probability density function for the interval T is obtained by summing the ordinates around the cylinder as illustrated in Fig. 4. The larger the ratio of σ (the standard deviation of the curve in Fig. 3) to T, the better the approximation of the wrap-around probability density to a uniform distribution. This is shown in Fig. 5 as a plot of ε, the

Electrical Engineering Education

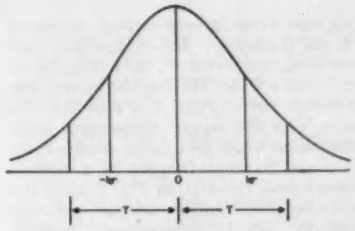


Fig. 3. Normal distribution curve.

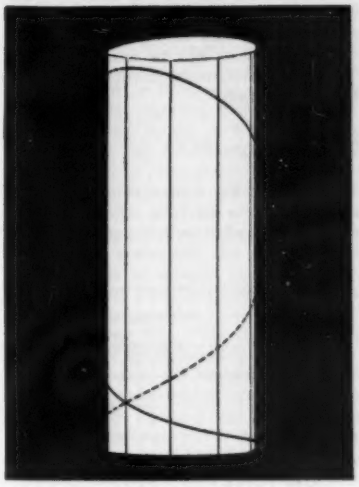


Fig. 4. Illustration of wrap-around principle.

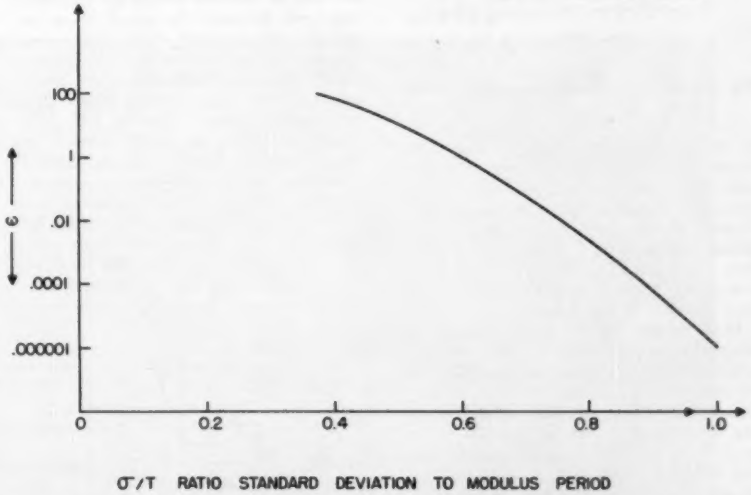


Fig. 5. Per cent error (ε) in peak-to-peak difference of probability density function vs σ/T ratio.

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per cent error in peak-to-peak difference of the probability density function over the modulus period T, as a function of the ratio σ/T for the original normal distribution curve. Thus, it is seen that if a delay unit can supply independent selection pulses whose probability density function can be approximated by a normal distribution curve as in Fig. 3, then the spinning disk random selector can successfully select independent, equally-likely random numbers.

An exactly normal distribution of positive time cannot be achieved, inasmuch as the normal distribution extends from minus infinity to plus infinity. However, distributions based on repeated exponential distributions can be easily achieved. These have probability densities expressed by the equation,

$$f_n(t) = \frac{t^{(n-1)}\, e^{-t}}{(n-1)!}, \quad 0 < t \qquad (1)$$

The curves of Fig. 6 show this type of distribution for $n = 1$, 2, 4, and 10. For $n = 1$ the distribution is exponential, and,

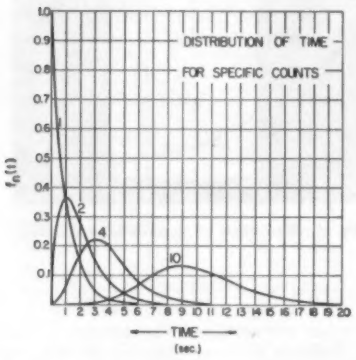

Fig. 6. Distribution of time for specific counts.

as n increases, the curves become bell-shaped and nearly normal except on the tails. Thus, if the curve for $n = 10$ is wrapped around a cylinder and the ordinates added, then the results will be almost the same as if a normal distribution had been used. This will provide an essentially uniform distribution over the final position of the spinning disk.

If a low-density radioactive source is allowed to decay naturally, then the distribution of time between emissions is exponential. This means that the distribution of time for n successive emissions has the distribution given in equation 1. In practice, it has been experimentally verified that the pulses from a Geiger-Muller (G-M) tube follow the same distribution as long as the count rate is well below saturation. Therefore, if the probability density of the time of the first pulse occurring is plotted vs time, curve 1 of Fig. 6 is obtained. Also if the probability density of the second, fourth, and tenth pulses is plotted vs time, the results will coincide with curves 2, 4, and 10 of Fig. 6. It should be remembered that the curve of the tenth pulse approaches a normal distribution curve; using this pulse is one way of obtaining a specific independent time distribution, which will, in turn, yield an essentially uniform probability density over the spinning disk.

Assume that the low-density radioactive source is positioned approximately 3 inches from a G-M tube so that the output pulses of the G-M tube are predominantly the result of this source, and are not caused by background emission or other external sources. The emitting power of this source is two or three times greater than that of the ordinary luminous dial wrist watch. Because of the inherent independence of particle emission from the radioactive source, the pulse emissions of the G-M tube are independent. Therefore, we have a source that emits pulses independently, and the tenth pulse of which provides an essentially uniform probability density over the modulus period of the counter tube.

The Random Delay Unit

A block diagram of the random delay unit is shown in Fig. 7. This unit employs a low-density radioactive source and a G-M tube to detect the emission of beta particles. The source and the G-M tube are positioned as discussed in the preceding section. For design purposes, a criterion of 1% deviation in the peak-to-peak difference of the wrap-around probability density was considered close enough to a uniform distribution. To achieve this criterion, the modulus time T equals approximately 1.6 times the standard deviation of the normal distribution curve as shown in Fig. 5. Inasmuch as a decade counter tube was available, the tenth pulse was chosen to be used. The output pulses of the G-M tube are fed into an inverter circuit for amplification and inversion to adapt them for driving the counter tube. The tenth cathode of the counter tube is used to supply the output selection pulse of the random delay unit. The counter tube puts out a voltage pulse on the tenth count, thus using the tenth count as the output selector pulse from the random delay unit. It should be remembered that the tenth count occurs randomly, and has a probability density function approximated by a normal distribution curve as in Fig. 3. Thus, we have the desired mechanism for our random delay unit in that this unit provides a selection pulse independently spaced, and provides a nearly uniform probability density function over the modulus cycle T.

Operation of Complete Unit

Now consider the complete radiation delay electronic spinning disk random selector as used for the psychophysical tests which were discussed at the beginning of the article. A block diagram of the selector is shown in Fig. 8. The radiation delay electronic spinning disk random selector is divided into three main units: (1) the random delay unit; (2) the driver unit, which programs each selection; and (3) the selection unit, which co-ordinates the random delay unit and driver unit input information to select and store the random selection. Two decade counter tubes are used, one in the selection unit and the other in the random delay unit. Hereafter, the decade counter tube in the random delay unit will be referred to as the radiation counter tube, and the decade counter tube in the selection unit will be referred to as the spinning disk. The random delay unit is similar to the one discussed under the subheading "The Random Delay Unit" with two minor refinements. One refinement, which cuts off the G-M tube when it is not used, projects the life expectancy of the G-M tube from about 2 months to about 10 years under normal running conditions of the equipment. The equipment in which the random selector is installed requires that a random selection be made cyclically about every 6 seconds. Since the random selector is not used during experiment setup time and observer rest periods, the G-M tube can be shut off during these periods.

The second refinement consists of blocking the radiation counter tube input immediately after a delay unit selection pulse is obtained. The G-M tube is cut off immediately after the tenth count of the radiation counter tube, but two or three pulses are emitted from the G-M tube while it is being cut off. These extra pulses would normally force the radiation counter tube to count, leaving only 7 or 8 of the possible 10 positions remaining on the counter tube until the tenth position is reached and a selection pulse emitted. This means that the next random delay selection pulse would be on the seventh or eighth count of the G-M tube, instead of the tenth. This undesirable counting is prevented by blocking the radiation counter input immediately after a selection pulse is emitted, thus insuring that the counter tube will be in the zero position for the next random selection, and will be able to count to the tenth pulse of the G-M tube before emitting a selection pulse.

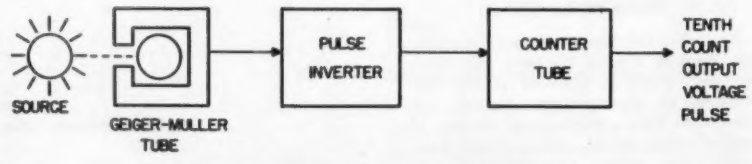

Fig. 7. Block diagram of random delay unit.

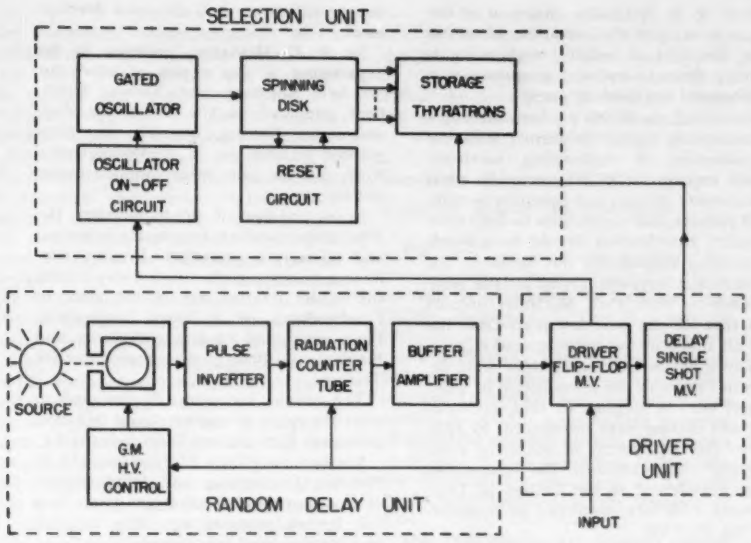

Fig. 8. Block diagram or radiation delay electronic spinning disk random selector.

The selection unit of the radiation delay electronic spinning disk random selector is similar to the basic spinning disk random selector discussed under the subheading "Basic Electronic Spinning Disk Random Selector." It has a decade counter tube with 10 possible glow positions, each of which represents one of the 10 possible, equally-likely random numbers. Instead of having a switch to interrupt the spinning disk for the selection, the oscillator is turned on and off. A bank of 10 thyratrons, one for each random number selection, stores the selection for later use.

The driver unit has a driven flip-flop circuit which initiates the random selector upon receipt of a "question" pulse from the associated programming equipment. This unit also has a delay single-shot multivibrator which, in coincidence with the spinning disk output, initiates the storage thyratron for storing the random selection. A buffer amplifier is used between the radiation counter tube and the driver flip-flop to amplify the counter output pulse and to insure isolation of the two circuits.

Now consider the sequence of operations of this circuit for one random selection. First, examine the stable states of the random selector circuitry. The driver flip-flop is in its off condition, which means: (1) the G-M tube is cut off, (2) the input from the radiation counter tube to the G-M tube is blocked, and (3) the oscillator in the selection unit is inoperative. The delay single-shot multivibrator is in its stable state. Both decade counter tubes have a stationary glow, which means they are not counting, and the storage thyratrons are in their non-conducting state waiting to be fired. The driver flip-flop now receives a "question" pulse from the associated programming equipment asking for a random selection. The driver flip-flop immediately does three things: (1) it connects the radiation counter tube to the G-M tube; (2) it turns on the G-M tube; and (3) it turns on the oscillator, thus starting the spinning disk. The radiation counter tube counts the 10 pulses from the G-M tube and then shuts off the driver flip-flop with its random delay output selection pulse. This, in turn, disconnects the radiation counter tube from the G-M tube and also cuts off the G-M tube, again making it inoperative. The gated oscillator is turned off, thus stopping the spinning disk in a random position. This position is the random number selection. Corresponding to this position, one and only one of the 10 storage thyratrons is triggered by a coincidence of two input pulses. One input is received from the spinning disk, and the other from the delay single-shot multivibrator. After a selection is made, and the spinning disk is stopped in its selected random number position, only the thyratron connected to that random number position will receive a pulse. When the driven flip-flop is turned off by the random delay output selection pulse, it triggers the delay single-shot multivibrator which, in turn, sends a pulse to all of the 10 thyratrons. Only the thyratron with the two inputs will be fired, enabling it to store the random selection.

An important feature of the radiation delay electronic spinning disk random selector is the adjustable modulus. Thus

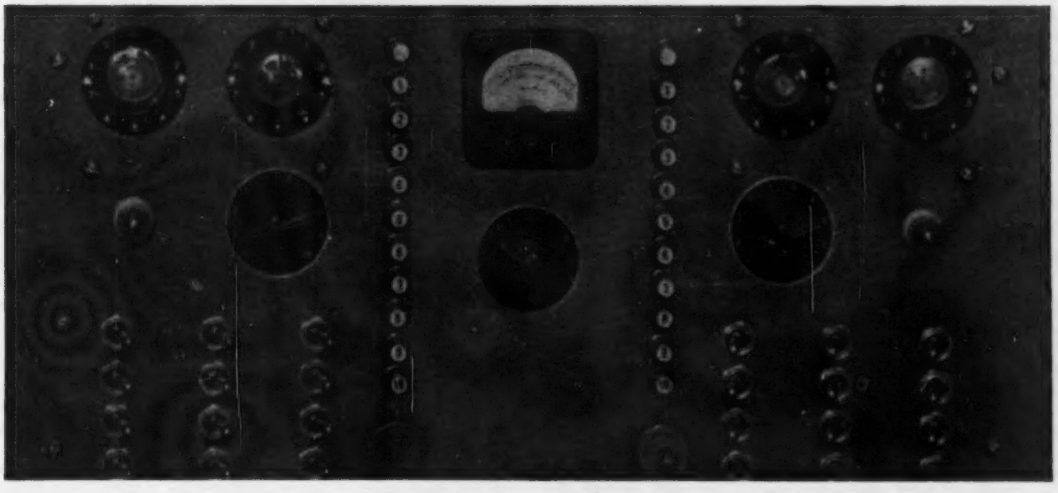

Fig. 9. Front panel of radiation delay electronic spinning disk random selector.

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far in the discussion, the modulus number has been assumed to be 10 (i.e., 10 unique stable states). This means that equally-likely random numbers between 1 and 10 may be selected with the probability of a certain number occurring equal to 0.10. Assuming a modulus number n, implying n unique stable states, the probability of a certain number between 1 and n occurring would be $1/n$. The modulus number of this unit is adjustable in integral steps from 2 to 10. All units of the random selector, except the spinning disk, operate in the same way for all modulus settings. For the given modulus number n, the spinning disk is allowed to pass through only n stable states and is then reset to position 1, thus skipping positions $(n+1)$ through 10. If the modulus number 4 is assumed, there are four unique stable states of the spinning disk, and the probability of a certain integer between 1 and 4 occurring is 0.25. The spinning disk will pass through four positions and then be reset to position 1, thus skipping positions 5 through 10. The reset block is shown in Fig. 8.

Conclusions

Fig. 9 is an illustration of the front panel of the actual radiation delay electronic spinning disk random selector. Notice the two decade counter tubes, the numbered selection lights, and the modulus switch. This chassis contains two identical random selectors, as can be seen in Fig. 9. One important feature of this unit is that it can select a random number every 300 milliseconds, which more than meets the requirements of the associated programming equipment. Another important feature is that the stability of the equally-likely probabilities is not dependent upon voltage as a reference. Thus, if the supply voltage varies, the probabilities will not change. This unit is currently being used for psychophysical testing at the University of Michigan.

ECPD Grants Accreditation to Welding Engineering Curriculum

Ohio State University's curriculum in welding engineering has been accredited by the Engneers' Council for Professional Development (ECPD), according to word received by President N. G. Fawcett.

The accreditation, the first in the United States, was granted in November. ECPD, a joint organization of engineering professional societies and engineering educators, is concerned with advancing the status of the engineer and the profession.

Prof. R. B. McCauley, chairman of the department, said that with the accreditation, the field of welding engineering is moving closer to national acceptance as a professional engineering group.

Since 1932, the ECPD has been the single co-ordinating agency concerned with the accreditation of engineering curricula. Upon request, an ECPD committee visits a university campus and examines records, staff policies, and capabilities to determine whether accreditation should be granted.

Welding engineering was added to the professional engineer group by the State of Ohio in 1950. Prof. McCauley pointed out that for the past few years Ohio has led all states in the welding market.

Education in welding at Ohio State began in 1893 with the introduction of welding of steel by forging. In 1919, gas welding and cutting were introduced. In 1925, when the department of industrial engineering was established, the laboratories were transferred to the College of Engineering with new emphasis on manufacturing processes.

The welding curriculum was advanced to an option degree in the department of industrial engineering in 1938 and in October 1947 a curriculum for the degree of bachelor of welding engineering was approved by the University, and the new department was established.

Author of the first curriculum in the new department was Prof. R. S. Green, who was named chairman. Upon Prof. Green's promotion to the post of executive director of the Engineering Experiment Station in 1954, Prof. McCauley was named department chairman.

The department has graduated some 92 with bachelor's degrees and 13 with master of science degrees. The nine laboratories in the department are: heat treating, design, testing, metallurgy, preparation, welding processes, welding research, radiation, and photography.

The A. F. Davis Welding Library is located in the same building and contains some 7,000 volumes on welding and related fields. It also contains a classification system for welding patents. There are currently nearly 15,000 United States and foreign patents in an easy-to-reach file system which is available to faculty, students, and industry. Nondestructive testing literature is also included in a similar classification system.

The department has taken an active role in research in welding engineering. An important area of study is in weldability and welding metallurgy. Basic studies and development of welding procedures have been accomplished in aluminum piping, magnesium alloys, titanium alloys, stainless steels, and highly hardenable alloy steels.

The nature of weld bonds, the state of stress in weld joint development, and the nature of the welding arc, are currently under study. Prof. McCauley and W. L. Green, instructor in the department, have begun a series of studies on the nature of discontinuities in welded materials and the effect of these discontinuities on weld serviceability.

Nondestructive testing investigations are centered around the areas of electronic fluoroscopy, solid-state X-ray detectors, isotope techniques, and ultrasonic development.

Dr. R. C. McMaster, professor in the department, is also serving as editor for the new Nondestructive Testing Handbook, prepared for the Society for Nondestructive Testing, Inc. He has been granted patents for a xeroradiographic X-ray process and other nondestructive test devices.

In its program of aid to industry, the department conducts courses for industrial and off-campus personnel. Evening conference courses, given for 8 weeks during the winter quarter, are in the areas of Fundamentals of Welding Engineering, Fundamentals of Resistance Welding, and Fundamental Principles of Nondestructive Testing.

The courses are primarily designed to meet the needs of engineers and technical personnel from central Ohio industries.

Summer workshops in Fundamentals of Welding Engineering and Fundamentals of Nondestructive Testing are given in a full 2-week program attracting national and international patricipants.

New Electrical Engineering Building at Yale University

Yale University's new $1.5 Electical Engineering building (see photo p. 238) was dedicated on November 1, 1958. The 5-storied structure with its glass, enameled steel, and limestone exterior is connected to Dunham Laboratory, the older center for electrical engineering, which has been modernized as part of the building program. Yale's electrical engineering department now has 80,000 square feet of integrated educational and research facilities to handle its expanding undergraduate and graduate student enrollment.

The new building, designed with the co-operation of the faculty, incorporates many noteworthy features. Fluorescent lighting that provides 80 foot candles of illumination in all working areas, sound proofed ceilings and asphalt tile floors throughout, an attractive Vitro-Glaze finish on all corridor and blackboard walls, and forced-air ventilation of class rooms, laboratories, and offices have resulted in a building that is pleasant to work in and easy to maintain. Adequate storage areas have been provided on each floor so that the working areas can be kept free of unnecessary equipment.

In addition to the laboratories for electrical machinery, measurements, and microwaves provided in the old wing, the new building provides separate laboratories for circuits, servomechanisms, electronics, communications, magnetics, and computers. Each laboratory has an associated instrument room workshop. Laboratory tables are supplied with a-c power and a number of special circuits through underfloor ducts which connect to a central switchboard on each floor. Each switchboard provides 400-cps and d-c power from remote-operated generators as well as single-phase and 3-phase 60-cps power and special circuits that connect to other switchboards in the building. In

the electronics, communications, servomechanisms, and magnetics laboratories, each table has a console that furnishes the controls and terminals for four electronically regulated d-c power supplies, filament supplies, and special circuits.

Electrical shielding was incorporated in the floors to minimize the transmission of electrical disturbances between laboratories. This shielding, coupled with the steel panels on exterior walls, provides a reasonably interference-free environment for ordinary r-f measurements. For more critical measurements, a completely shielded room was constructed within the communications laboratory.

The air-conditioned computer laboratory is equipped with an analog computer and plotting tables, and space is provided for a digital computer to be acquired later. All offices in the new building have adequate power outlets and special circuit connections to the switchboards, so that they may be used for research rooms. A complete darkroom is provided for photographic work in connection with research projects. Conference rooms are provided on each floor, so that small discussion groups and committee meetings need not compete for classroom space.

RCA Grants 63 Undergraduate Scholarships

The Radio Corporation of America (RCA) has awarded 63 undergraduate scholarships to college and university students for the current academic year, it was announced recently by Dr. C. B. Jolliffe, RCA vice-president and chairman of the RCA Education Committee.

Some 30 of the awards, designated as RCA Scholarships and valued at $800 each, were made to students studying in fields related directly to the electronics and broadcasting industries, as well as to the nation's security. Three other $800 RCA Scholarships were awarded to honor graduates of RCA Institutes.

The remaining 30, designated as RCA Science Teacher Scholarships, were made to students preparing for careers as mathematics, physics, chemistry, biology, or general science teachers. Of the Science Teacher awards, 20 are valued at $800 each, and were made to junior or senior students. Some 10 others, valued at $250 each, were made to freshmen or sophomore students.

In addition, RCA has made an unrestricted contribution of $500 to each of the independent colleges and universities maintaining the awards.

The 63 scholarships are a segment of RCA's four-part student aid program which this year will help 84 full-time college students and 2,790 RCA employes further their education," Dr. Jolliffe said.

Of the RCA Scholarships, 25 went to students majoring in science. One was awarded in music and one was made to a business administration major. Three others were awarded jointly by RCA and the National Broadcasting Company for study in dramatic arts and television training.

The RCA Science Teacher Scholarships, awarded for the first time last year, are established at 20 colleges and universities in 16 states where a survey by the RCA Education Committee showed the shortage of such teachers to be most critical.

Southern Regional Graduate Summer Session in Statistics

The 1959 session of the Southern Regional Graduate Summer Session in Statistics will be held at North Carolina State College, Raleigh, N.C., June 8 to July 17, 1959.

North Carolina State College, Virginia Polytechnic Institute, University of Florida, and Oklahoma State University have agreed to operate a continuing program of graduate summer sessions in statistics to be held at each institution in rotation; the program was instituted at Virginia Polytechnic Institute in the summer of 1954.

The 1959 session, like previous sessions under this program, is intended to serve: (1) teachers of introductory statistical courses who want formal training in modern statistics, (2) research and professional workers who want intensive instruction in basic statistical concepts and modern statistical methodology, (3) professional statisticians who wish to keep informed about advanced specialized theory and methods, (4) prospective candidates for graduate degrees in statistics, and (5) graduate students in other fields who desire supporting work in statistics.

The session will last 6 weeks and courses will carry three semester hours of credit.

Electrical Engineering Education

Not more than two courses may be taken for credit at any one session. The summer work in statistics may be applied as residence credit at any of the co-operating institutions, as well as certain other universities, in partial fulfillment of the requirements for a graduate degree. The program may be entered at any session, and consecutive courses will follow in successive summers so that it would be possible for a student to complete the course work in statistics for a master's degree in three summers. Students must satisfy the remaining requirements for course work and thesis at the institution where they are to be admitted to candidacy. The advanced courses may be accepted as part of the Ph.D program of the participating institution.

The courses to be offered in statistics in 1959 at Raleigh are as follows: Statistical Methods I and II; Statistical Theory I, II, and III; Theory of Sampling Applied to Survey Design; Stochastic Processes and Their Applications; Methods of Operations Research; and Advanced Topics in Statistical Methods.

Requests for application blanks for the summer school should be addressed to: F. E. McVay, Department of Experimental Statistics, North Carolina State College, Raleigh, N. C.

An Electrical Engineer in Industry

T. F. FLYNN (AM '52), engineer, Perkin-Elmer Corporation, Norwalk, Conn.

"The AIEE serves me in two ways—directly, by keeping me informed of new developments, and indirectly, through its fight for unity and professionalism. As a member of the AIEE, you, too, fly the banners of high professional standards and important technical knowledge.

"A significant factor in your future is your technical education. Through the AIEE publications and technical meetings, you are kept abreast of new developments in relation to their importance.

"The fight for unity and professionalism is in many respects an even more significant symbol of the AIEE. It is a long-range program which has the objective of raising the social status and professional dignity of the engineer. Both programs are a necessary part of your future. They represent good reasons why you should be a member of the AIEE."

Mr. Flynn was born February 27, 1927, in New Haven, Conn. He received the bachelor of engineering degree in February 1950, and the master of engineering degree in June 1951, both from Yale University. He has also done graduate work at Columbia University and taught electronic engineering courses at the University of Connecticut. At the Perkin-Elmer Corporation, he has worked as project engineer on the design of analytic laboratory spectrometers.

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First Atomic Reactor for State of Wyoming

The first atomic reactor for the State of Wyoming was purchased recently from Atomics International, a division of North American Aviation, Inc., by the University of Wyoming for advanced study in nuclear science and reactor engineering.

Atomics International will deliver an *L-77* Laboratory Reactor to the University's Laramie, Wyo., campus where it will be used for research and training. It is one of six 10-watt, solution-type Laboratory Reactors designed and built by the company for educational, medical, and industrial research.

Dr. C. A. Cinnamon, professor of physics at the University, said the reactor will be used primarily in graduate study programs in reactor engineering and technology, radiation chemistry, and reactor physics. It also will produce radioactive isotopes for research in the Schools of Agriculture, Pharmacy, and Arts and Sciences, the College of Engineering, and the Natural Resources Research Institute.

"Atomics International's *L-77* Laboratory Reactor will benefit Wyoming by helping it keep abreast of the times in this new adjunct to education," Dr. Cinnamon stated.

"We are delighted with the ease of operation of this reactor; its inherent safety features; as well as its inherent design and capability of going to higher power at very little additional expense," he added.

The *L-77* is 8 feet high and 8 feet in diameter and can be installed in a laboratory or industrial plant without adding special facilities.

It is similar to a Laboratory Reactor now operating at Atomics International's plant in Canoga Park, Calif. Another *L-77* was operated by the company at the Atomic Energy Commission's Reactor Training Exhibit at the recent Second International Conference on the Peaceful Uses of Atomic Energy in Geneva, Switzerland.

Grant Made for Electronic Music Center

Columbia and Princeton Universities have jointly announced the receipt of a grant of $175,000 from the Rockefeller Foundation for the purpose of establishing the first American center devoted to composition and research in electronic music.

The two Universities said the grant, which will cover a 5-year period, provides for acquisition and design of electronic equipment and its maintenance, technical assistance to composers, and, in general, for the establishment of conditions necessary for realization of such a program. The term "electronic music," it was explained, describes a music which can be created directly from electronically generated or electronically modified sounds. It can be presented only by means of electronic reproduction; however, combination with orchestral instruments and voice also occurs.

Studios already devoted to some aspects of this work exist in Cologne, Milan, Paris, and Tokyo. Other centers are contemplated. In the United States, a small studio exists at Columbia University.

At the Columbia studio, Otto Luening, professor of music, and Vladimir Ussachevsky, associate professor of music, carried out their "tape music" experiments and compositions, which these composers first introduced in the United States in 1952. The new center to be established through the Rockefeller grant will also be located at Columbia and will be administered jointly by Prof. Luening and Prof. Ussachevsky and, from Princeton, composers Roger Sessions, William Shubael Conant, professor of music, and Milton Babbitt, associate professor of music.

Research and experimentation in electronic music date back a half a century, but intensive development of the medium was stimulated by post-war development of the new electronic devices, especially the tape-recorder. The unique American contribution in this area has been the RCA Electronic Music Synthesizer, the most elaborate and self-contained instrument designed for the purpose of producing electronic music.

Two-Year Engineering Graduate Programs at U-M

Two-year programs of graduate study in engineering at The University of Michigan (U-M) were approved by the Regents recently.

The programs to be given by the School of Graduate Studies will require 30 credit hours of work beyond the master of science in engineering level or its equivalent to be taken at U-M with a grade average of B or better.

In recommending the new 2-year programs to the Regents, the Executive Board of the graduate school said, "The board believes that these degrees will satisfy a real need for additional training in the professional fields of engineering." The new programs will permit a broader subject-area training than is now required for a master's degee.

The programs shall include at least 24 hours in the area of the department of program cited in the degree, at least 6 hours devoted to a research, design, or development problem, at least 3 courses in cognate fields other than mathematics, and at least 9 credit hours in mathematics beyond the B.S.E. mathematics requirements of the department cited in the degree.

At the present time, the degrees to be awarded shall include aeronautical engineer, civil engineer, chemical engineer, metallurgical engineer, electrical engineer, industrial engineer, mechanical engineer, nuclear engineer, applied mechanics engineer, and marine engineer. Additional degrees of this type may be added if the need develops.

While initiating the new degree programs in engineering, the Executive Board requested the discontinuance of professional degree programs in engineering, forestry, and wood technology now in existence which required several years of experience in industry before a degree could be granted. Demand for this type of professional degree was reported to be negligible and the Regents approved the request for them to be discontinued.

Appointments and Awards Engineering and Science Faculty

Columbia University, New York, N. Y. Dr. Chien Shiung Wu, professor of physics at Columbia, has received the 1958 Research Corporation Award for her part in overthrowing the Parity Law. Her experiment, conducted with the co-operation of Dr. Ernest Ambler and co-workers at the U. S. Bureau of Standards in Washington, D. C., has been termed the "solution of the No. 1 riddle of atomic and nuclear physics."

Lehigh University, Bethlehem, Pa. Joseph Teno, assistant professor of electrical engineering at Lehigh University, has been granted a National Science Faculty Fellowship of $6,300. He has been granted a 9-month leave of absence, effective July 1, to enable him to accept the award and to complete work for his doctorate.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. A. D. Gronner (M '50), senior research engineer of the American Machine and Foundry Company–General Engineering Laboratories, Greenwich, Conn., has been appointed an adjunct professor by the Polytechnic Institute of Brooklyn. Mr. Gronner will teach at Polytechnic's new center for graduate studies in Westchester. At this second off-campus center, at the White Plains Senior High School, Mr. Gronner is presenting an electrical engineering course, Synthesis of Linear Feedback Systems.

TRIGA Begins Operating at University of Arizona

With the placement of fuel elements containing 2.2 kilograms of enriched uranium into its nuclear core, the TRIGA research reactor at the University of Arizona (UA) began operating on December 6.

Dr. R. A. Harvill, UA president, and Dr. Frederic de Hoffmann, a vice-president of General Dynamics Corporation and general manager of the corporation's General Atomic Division, jointly announced the beginning of operation of Arizona's first atomic reactor.

The first educational institution in the world to operate the newly developed,

multipurpose, inherently safe nuclear reactor known as TRIGA, the UA, in cooperation with General Atomic, who developed the unique reactor, began work on the installation late in the Spring of 1958 (*EE*, June 1958, p. 569).

Located on the UA campus in the north wing of the College of Engineering building, the reactor's purchase was financed in part through a grant of $110,195 from the U.S. Atomic Energy Commission.

The University's electrical engineering department will use TRIGA as part of a broad program of research and teaching to include reactor engineering, the study of isotope production and use, and instrumentation through the use of isotopes.

The usefulness of the TRIGA reactor is broad enough to include many other UA departments—chemistry, physics, bacteriology, zoology, botany, various kinds of agriculture, metallurgy, and mechanical engineering.

The ability of TRIGA to produce isotopes will make the reactor immensely valuable to the medical profession, too, and the reactor also is capable of extensive use in special industrial research projects.

Electrical Engineering Students Meet with Local Section of AIEE

Members of the Oregon State College Student Branch of AIEE from Corvallis, Oreg., met with the Portland Section of the Institute recently, at a Smorgasbord dinner at the Oregon Museum of Science and Industry. The purpose of the meeting was to give the students opportunities to meet practicing engineers, to discuss mutual problems, and to talk about their future in the profession.

John Nelson, superintendent of lighting for the City of Seattle and vice-president of District No. 9 of the Institute, addressed the dinner meeting.

Also on the agend. were the presentation of Fellows Awards by Mr. Nelson to Corbett McLean, engineering supervisor of Pacific Power & Light Company; D. L. Brown, chief test engineer of Portland General Electric Company; C. H. Bjorquist, assistant chief of design, Bonneville Power Administration; R. F. Stevens, chief of design, Bonneville Power Adminstration; T. W. Stringfield, chief electronics and communications, Bonneville Power Administration.

The meeting was arranged by J. G. Kirwan, immediate past chairman of the Portland Section who was recently elected president of the Oregon Museum of Science and Industry. This was the first large group meeting to be held at the recently completed Oregon Museum Building, a feature of which will be the McMillan Memorial Room, a room dedicated to F. O. McMillan, former president of the Institute. The Portland Section has been very active in the drive to raise necessary funds to complete this memorial.

Dedication Ceremonies for Caltech's Radio Observatory

Dedication of the California Institute of Technology Radio Observatory on December 19 marked completion of virtually all mechanical construction and the start of the "shakedown" phase of the $1.5 million installation.

Participating in the formal dedication at the observatory site in Owens Valley 250 miles north of Caltech's campus in Pasadena were Dr. L. A. DuBridge, Caltech president; Rear Adm. Rawson Bennett II, Chief of Naval Research; J. G. Bolton, scientific director of the observatory; and A. B. Ruddock, chairman of Caltech's board of trustees.

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They said the giant twin "ears" soon will be listening to the stars and adding to man's knowledge of the universe. Mr. Bolton explained that radio astronomy is an extension of optical astronomy and consists of "observing" a range of wavelengths longer than the eye can see. The range covers both radio and television bands.

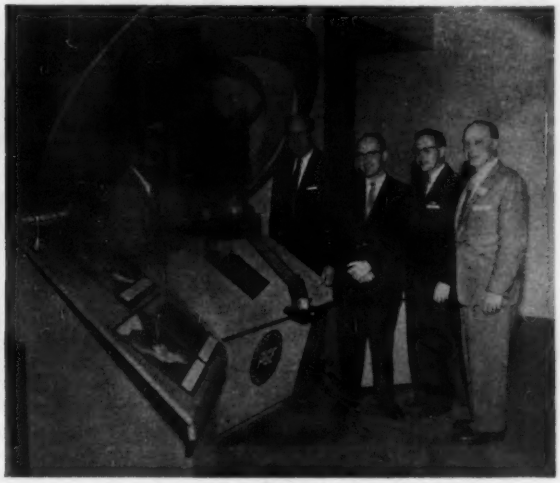
Among guests at the ceremony were members of Caltech's board of trustees, representatives of contracting firms that built the observatory, residents of Owens Valley who have participated in the project, and officials of the U.S. Navy, whose Office of Naval Research (ONR) has financed it.

While visitors toured the 300-acre site and heard the brief dedicatory addresses, crews continued their work on observatory equipment.

The observatory is going through a "shakedown" phase that may require months. Many "bugs" must be eliminated and adjustments made to achieve the high degree of precision and accuracy required of the twin telescopes and their instruments.

Each 90-foot diameter steel mesh, dish-shaped antenna skin is adjustable at 324 points. This is to assure a perfect parabola and consequently an accurate reception of signals, explained B. H. Rule, Caltech chief engineer.

The dish reflectors catch the signals and focus them to a point, just as an optical telescope mirror focuses light waves to an eyepiece. Instead of an eyepiece, however, the focussed radio signal beam is caught



A RECENT DINNER MEETING of the Portland Section of the Institute (above, *left*) gave members of the Oregon State College Student Branch an opportunity to discuss their future in the electrical engineering profession with practicing engineers. Above, right: Scene of the meeting was the Oregon Museum of Science and Industry where a group views an exhibit: (*left to right*) D. P. Huegli, director of the Oregon Museum of Science and Industry; John Nelson, vice-president, AIEE District No. 9; Dale Ulm, student chairman; Les Wolgast, chairman, Portland Section; J. G. Kirwan, president of the Oregon Museum of Science and Industry.

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by a radio receiver suspended over the reflector and is amplified and projected on magnetic tapes, oscilloscopes, or pen recorders.

The dishes move separately or may be used as a team for interferometry to pinpoint positions of signal sources.

Many other adjustments remain to be made, and more of the complex electronic equipment must be installed and tested. Some of the instrumentation was developed specifically for this observatory.

It is hoped that all construction and installation work will be completed by May —except for additions or replacements. The full scientific program is not expected to get under way until about then.

The program will include attempts to identify hundreds of radio sources in space with visible stars so that the mechanism for generating the signals can be studied. Some of the objects are stars and some are other celestial phenomena, such as two colliding galaxies and vast, luminous clouds of hydrogen.

Studies also will be made of bursts of atomic particles blasted into space from the sun and responsible for the aurora borealis.

In addition to the two big dishes, the observatory has other radio astronomy facilities. They include a 32-foot antenna, built some time ago, chiefly to develop electronic equipment for the 90-foot dishes. Then there are two arrays, which are networks of wires that serve as very large antennas.

One array covers 2 acres and the other, 10. Since they are too large to be movable for tracking radio stars, they were used only for making observations of objects while they were directly overhead. With the large dish antennas about completed, there are no immediate plans to use the arrays further.

The observatory will operate on an annual budget of about $150,000, furnished by ONR. ONR has contributed more than $1.3 million for development and construction. Winnett Trust Fund has appropriated $74,000 and Radio Corporation of America $25,000.

Contractors for the job are C. W. Jones Engineering of Los Angeles; Allison Steel Co. of Phoenix, Ariz.; Keystone Engineering Co. and Amercon Corp., both of Los Angeles.

Midwest Symposium on Circuit Theory

The 4th Midwest Symposium on Circuit Theory will be held December 1-2, 1959, at the Brooks Memorial Union, Marquette University, Milwaukee, Wis. Technical papers are desired for the sessions of this convention. The following are typical fields of interest: active network circuit analysis and synthesis, passive network circuit analysis and synthesis, network topology, realizability conditions, new circuit elements, high frequency network analysis, matrix applications to circuit analysis.

Authors should submit a 100-word abstract of their paper by May 1, 1959. The Program Committee will notify authors of the programming of papers as early as possible, at which time detailed information on standardized preparation will also be furnished so as to permit reproduction of the symposium proceedings. It is planned to publish the convention proceedings early enough to permi the distribution at the time of the convention. Completed papers will be required by September 15, 1959.

The Midwest Symposium has been held at Michigan State, University of Illinois, and Iowa State.

AEC Grants Awarded to 41 Universities and Colleges

J. A. McCone, chairman of the Atomic Energy Commission (AEC), announced recently that the AEC has approved grants totaling $2,264,965 to 41 universities and colleges for the purchase of laboratory equipment needed to expand their nuclear educational programs in the physical sciences and engineering. These grants are part of the AEC's program to assist in providing trained manpower for the atomic energy field.

These awards mark the fifth in a series of grants under this program and bring to $10,929,674 the total that has been allotted to 106 United States educational institutions.

The 41 grants include funds to seven engineering institutions for the purchase of teaching reactors. Institutions receiving funds for this purpose are University of Illinois, Kansas State College, University of Maryland, University of Texas, University of Washington, West Virginia University, and University of Wisconsin.

The seven reactor grants bring to 30 the total number of teaching reactors in operation, under construction, or to be constructed on campuses throughout the United States with the help of AEC grants. To be awarded funds for a teaching reactor a college must be accredited by the Engineers' Council for Professional Development and have a broad graduate nuclear curriculum. All schools receiving reactor grants are required to obtain licenses to construct and operate their reactors and to possess the nuclear reactor fuel.

The AEC's program is intended primarily to assist qualified engineering schools in establishing or expanding their nuclear educational programs at the graduate level. Some assistance is provided to qualified nonengineering colleges offering 4 years of undergraduate work, depending upon the availability of funds for this program.

Engineering Scholarship Winners

W. D. MILLER *(right)*, vice-president and general manager, Fulton Sylphon Division, Robertshaw-Fulton Controls Company, presents winners in regional scholastic competition with 4-year scholarships to University of Tennessee School of Engineering. Winners also received cash awards. The three winners are: *(left to right)* L. V. Price, C. H. Wilson, and G. M. Oliver, all of Knoxville, Tenn. They enrolled as freshmen at the University to study electrical engineering. Mr. Miller said, "The scholarships (valued at $1,300 each) are intended as a contribution to the engineering profession at a time when the nation needs young engineers to keep its world leadership in technology."

Wear Your ◆ AIEE Badge

INSTITUTE ACTIVITIES

Atlanta, Ga., Will Be Host to AIEE Joint District Meeting

ATLANTA, GA., will be host to the AIEE Joint District Meeting for the Southeast District No. 4 and South Central District No. 13, April 7-10, 1959, with headquarters in the Dinkler Plaza Hotel. "Industry Is Humming DIXIE" has been selected as the theme of the meeting, which will feature technical sessions, social events, and inspection trips of unusual interest.

General Session

The general session will be called to order in the Dinkler "B" Room at the Dinkler Plaza Hotel at 9:30 a.m., Wednesday, April 8, by R. G. Elliott, general chairman of the Joint District Meeting. His Honor, W. B. Hartsfield, mayor of Atlanta, will give the address of welcome and present Keys to the City to H. W. Oetinger and C. P. Knost, vice-presidents of District No. 4 and No. 13. The principal speaker will be Dr. E. D. Harrison, president of the Georgia Institute of Technology, who will have as his subject the theme of the Joint District Meeting, "Industry Is Humming DIXIE."

General Luncheon

At the noon general luncheon Dr. Pierce Harris, pastor of the First Methodist Church of Atlanta, will be the principal speaker. C. B. McManus, chairman of the board of the Southern Company, will be presented his Fellow diploma by W. E. Mitchell, a "Member for Life" of the Institute.

Registration

A unique method of recording and sorting requested information will be used. A telephone communication link between the campus of Georgia Tech and the hotel lobby will convey the information. In addition, a closed-circuit television will display the computer operation at the hotel.

Advance registration cards included with the mailed announcement should be mailed to D. C. Kyker, 1860 Peachtree St., N. W., Atlanta 2, Ga., in order to avoid delay. Members may pay registration fees upon arrival when they pick up identification badges, programs, etc. The Registration Desk, in the main lobby of the Dinkler Plaza Hotel, will be open Tuesday afternoon, April 7, for those arriving early, and daily thereafter during the meeting.

Hotel Reservations

All advance hotel reservations should be made through the Housing Bureau, AIEE, Room 720, Rhodes-Haverty Building, Atlanta, Ga. Confirmation will be mailed to members directly by the hotel accepting the reservation. If rooms at rates requested are not available, room at the next higher rate available will be assigned. In case assistance is needed, the Chairman, Hotel Committee, should be contacted. Address requests to J. A. Busha, Chairman, Hotel Committee, Southern Bell Telephone & Telegraph Company, 729 Hurt Building, Atlanta, Ga.

A hotel reservation and rate card (no postage required) will accompany the mailed announcement. As indicated, it should be sent directly to the Housing Bureau. If the card is mislaid or lost, write to either Mr. Busha or the Housing Bureau. Please indicate on reservation cards the time of arrival and departure. If it is necessary to correspond with the Housing Bureau or hotel regarding room reservations, please mail a copy of the letter to Mr. Busha. If an acknowledgment from the hotel is not received within 10 days, write to the Housing Bureau, furnishing duplicate information.

Rates for the rooms at the hotels in the vicinity of the headquarters are shown in the accompanying table.

Reservations must be received by the Housing Bureau not later than March 20. Members are urged to mail their reservations as early as possible, in order to be assured of getting their desired accommodations. Every effort will be made by the local committee and the Housing Bureau to handle reservations received after the deadline, but this may prove difficult after the hotel has released rooms which were held for this meeting. Rooms will be held only until 6:00 p.m. on the date of arrival unless a later hour is specified.

Off-street parking for 1,000 cars is available in the vicinity of the hotels. Pick-up and delivery service for cars is also available at the hotel entrances. Airport limousines leave from all downtown hotels and all airline ticket offices are located directly across the street from the Dinkler Plaza. Railroad transportation must be arranged at either the Atlanta Terminal or Union Station. The Union Station is located four blocks from the Dinkler Plaza and the Terminal Station six blocks.

Social Hour

On Wednesday evening, April 8, from 6:00 p.m. to 7:00 p.m., a "Get Acquainted Social Hour" will be held in room Dinkler "B." A second social hour will be held in room Dinkler "B" on Thursday from 6:00 p.m. to 7:00 p.m. These social hours are on a pay-as-you-go basis with no ticket sales.

Dinner-Dance

A full evening's entertainment has been arranged in the form of a dinner dance on Thursday evening, April 9, with music by Bill Clarke's orchestra. For after-dinner relaxation, an excellent floor show is planned. Tickets to this occasion will be $6 per person.

Ladies Events

The following events should provide interesting entertainment for the ladies accompanying their husbands to the District Meeting. A Ladies Hospitality Room will be maintained in Plaza "A" throughout the meeting. Each morning from 8:30 to 9:30, coffee and doughnuts will be served.

On Wednesday morning, there will be a Courtesy Breakfast and Fashion Show in the Magnolia Tea Room, 6th floor, at Rich's Inc., one of the nation's largest department stores.

On Thursday morning, there will be a tour, including a visit to the Cyclorama, one of the world's largest and most famous paintings, depicting the Battle of Atlanta; the Dogwood Trail; and Atlanta's residential section. This tour will

Hotel	Single	For Two Persons		
		Double Bed	Twin Beds	Suites
Dinkler Plaza (Hdqrs.)	$7.00-$12.50	$10.00-$12.50	$14.00-$16.50	$12.50-$41.00
Piedmont (across St. from Hdqrs.)	6.00- 9.00	9.50- 11.00	10.00- 15.00	25.00- 30.00
Atlantan (1 block from Hdqrs.)	5.00- 7.50	7.00- 9.00	9.00- 11.00	20.00
Georgia (1 block from Hdqrs.)	5.00- 8.00	7.00- 9.00	8.50- 12.00	18.00- 20.00
Peachtree on Peachtree (2 blocks from Hdqrs.)	6.00- 7.00	8.50- 10.50	9.00- 11.50	11.00- 16.00
Henry Grady (2½ blocks from Hdqrs.)	7.00- 14.00	10.00- 16.00	11.00- 16.00	20.00- 35.00
Students, 2 or 3 to a room	2.50 per person			

be concluded by a smorgasbord luncheon at the Luau, a famous Polynesian Restaurant.

Inspection Trips

A program of inspection trips of both technical and general interest has been arranged for those attending the District Meeting. Since the number of persons who may be accommodated on each of these trips is limited, members who are interested are urged to obtain full details at the Inspection Trips Desk immediately after arrival.

On some of the trips, proof of U. S. Citizenship will be required, and members should be prepared to comply with such security regulations as may be in force at the time of the trip.

Carling Brewing Co. (Wednesday afternoon). Visitors will see a new multimillion dollar plant—the first brewery built in the South in 25 years. It consists of four major units—the brew house, storage and fermentation building, powerhouse, and bottling and shipping building, all located on a 35-acre tract. Exceptionally high-quality standards required the installation of complicated control equipment. Carlings will entertain the group in their luxuriously appointed lounge.

Georgia Power Co., 230-Kv Morrow Substation (Wednesday afternoon). Visitors will be shown the largest substation on the Georgia Power Company system. Power is brought to the substation over two 230-kv lines from Plant Yates and leaves over eight 115-kv and three 46-kv lines. Equipment includes two 125,000-kva, 230/115 volt autotransformer and two 20,000-kva 115/43.8-kv load tap changing transformer. The station is fully automatic with superimposed supervisory control from the boulevard dispatcher's office.

Lockheed Aircraft Corporation (Thursday Morning). Visitors will see one of the largest aircraft plants—76 acres under one roof—in the United States. Five aircraft final assembly lines, with complete fabrication and subassembly support, can be operated simultaneously in this building. This plant builds America's first prop-jet cargo–transport plane. Design work is under way in the Nuclear Laboratories on a nuclear powered aircraft. Design and experimental testing is being carried out on a vertical rising jet aircraft, drones and drone launchers, big jet cargo transport, and boundary layer control planes. Other products are nuclear reactors for process heat in industry and for training and research in colleges; also support equipment for missiles and space craft.

Owens-Illinois Glass Container Division (Thursday afternoon). Visitors will tour one of the world's most modern glass container plants with the two largest glass-melting furnaces of this type in the world. Unique in its field is the "batch" operation which automatically measures and mixes the raw materials and conveys them to the furnaces on demand without a single human action. After reaching 2,700 F, the molten glass flows to forming machines where bottles and jars are formed. These newly blown containers move through annealing lehrs to remove stresses and then through the labeling and packaging processes. The electrical system consists of dual power supplies to critical loads. Small power and lighting loads are fed through a 480Y/277-volt system.

Ford Motor Company Assembly Plant (Thursday afternoon). One of the major automobile plants in the nation covering more than 1 million square feet with a capacity of 640 Fords per day will be visited. The assembly area itself is more than a quarter mile in length. The precise timing and automatic control of equipment and processes is an impressive sight.

Georgia Institute of Technology Computer Center (Thursday afternoon and Friday morning). Participants (limited to 30 each trip) will play the management game. They will make decisions in connection with financing, budgeting, product pricing, etc., of a mythical company. These decisions will be fed into a computer which will evaluate their effect on the company for an 8-year period.

Southern Railway Company's Inman Yards (Friday morning). Visitors will see the newest classification yard in the southeast with a capacity of 8,170 cars and 50 diesel units. A complete system of automatic car retarders is used in classifying cars. Communications are carried on through a system of 4 television towers, 4 video amplifier houses, 60 paging speakers, 90 talk back speakers, 400 ground line speakers, and 40 walkie-talkie radios.

Atlantic Steel Company Rod & Merchant Mill (Friday morning). Visitors will be shown one of the most modern steel rolling mills in the world. The combination rod and merchant bar mill produces a variety of products ranging from No. 5 rod, coiled, to 4-inch channels and 4-inch angles. Rod finishing speed is 5,000 feet per minute. The mill contains 13 main drive motors totalling 8,300 hp. These motors operate at 700 volt d-c. Two pumpless type ignitron rectifiers rated 1,500 kw and 3,500 kw provide d-c current. A 25-minute color movie of the mill will be shown prior to the trip.

Telephone Company (Friday afternoon). Visitors will see the toll operating and test rooms where the equipment for operating and testing of automatic toll calls, television operating center, microwave radio relay terminal equipment, carrier telephone circuits, and special services will be shown and explained by a tour leader. Lunch will be served in the company cafeteria prior to starting the tour.

LARGEST AIRCRAFT PLANT UNDER ONE ROOF. An inspection trip to the Lockheed plant will be held during the Joint District Meeting of the Institute, April 7-10, 1959.

Committee

Members of the Joint District Meeting Committee are: R. G. Elliott, general chairman; J. W. Davis, vice-chairman; W. S. Brown, secretary-treasurer; Mrs. J. W. Davis, women's activity; T. J. Allen, transportation; J. A. Busha, hotel; C. L. Emerson, finance; J. D. Howard, technical program; J. C. Howell, fersommling; D. C. Kyker, Jr., registration; L. H. Curtis, Jr., publicity; E. G. Riley, inspection; Prof. E. R. Weston, student activities; J. F. Willett, dinner dance; W. J. McKune, vice-chairman, Georgia Section AIEE.

Mailed Announcement

A mailed announcement of this meeting will be sent to members in District No. 4 and No. 13. If a copy is desired by members in other Districts, please write to E. C. Day, Assistant Secretary for Technical Papers and Programs, TOD, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

(Continued on p. 250)

AIEE Future Meetings

AIEE-IRE-ACM Western Joint Computer Conference*
Fairmont Hotel
San Francisco, Calif.
March 3-5, 1959

American Power Conference*
Sherman Hotel
Chicago, Ill.
March 31-April 2, 1959

Textile Industry Conference*
Heart of Atlanta Motel
Atlanta, Ga.
April 2-3, 1959

EJC Nuclear Congress*
Municipal Auditorium
Cleveland, Ohio
April 5-10, 1959

AIEE-AWS Electric Welding Conference*
Hotel Sherman
Chicago, Ill.
April 6-10, 1959

AIEE-ASME Railroad Conference*
Hotel Sheraton
Chicago, Ill.
April 8-9, 1959

Southern District Meeting*
Dinkler Plaza Hotel
Atlanta, Ga.
April 8-10, 1959

Material Handling Conference*
Pfister Hotel
Milwaukee, Wis.
April 14-15, 1959

Electric Heating Conference*
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 14-15, 1959

Electrical Problems in the Cement Industry Conference*
Americus Hotel
Allentown, Pa.
April 15-16, 1959

Recording and Controlling Instrumentation Conference*
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 20-21, 1959

East Central District Meeting*
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959

Rubber and Plastics Conference*
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959

Empire District Meeting*
Hotel Syracuse
Syracuse, N. Y.
April 29-May 1, 1959

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
May 6-8, 1959
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—March 2)

AIEE-ASME-IRE Automatic Techniques Conference
Pick Congress Hotel
Chicago, Ill.
May 11-13, 1959
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—March 6)

Domestic Appliances Conference
Hotel Manger
Cleveland, Ohio
May 18-19, 1959
(Final date for †TP—closed, ‡CP Syn.—March 3, CPMs—March 13)

Middle Eastern District Meeting
Lord Baltimore Hotel
Baltimore, Md.
May 19-21, 1959
(Final date for †TP—closed, DPMs —March 13)

AIEE-ISA-ARS-IAS National Telemetering Conference
Brown Palace and Cosmopolitan Hotel
Denver, Colo.
May 24-27, 1959
(Final date for †TP—closed, ‡CP Syn.—March 10, CPMs—March 20)

International Conference on Information Processing
UNESCO House
Paris, France
June 15-20, 1959
(Exhibits June 13-22)

Paper and Pulp Conference
University of Maine
Orono, Maine
June 18-19, 1959
(Final date for †TP—March 20, ‡CP Syn.—April 3, CPMs—April 14)

Summer and Pacific General Meeting
Olympic Hotel
Seattle, Wash.
June 21-26, 1959
(Final date for †TP—March 23, ‡CP Syn.—April 7, CPMs—April 17)

Air Transportation Conference
(at Summer General Meeting)
Olympic Hotel
Seattle, Wash.
June 22-26, 1959

Petroleum Industry Conference
Wilton Hotel
Long Beach, Calif.
August 23-26, 1959
(Final date for †TP—May 25, ‡CP Syn.—June 9, CPMs—June 19)

AIEE-ASME Engineering Management Conference
Statler Hotel
Los Angeles, Calif.
September 16-18, 1959
(Final date for †TP—June 18, ‡CP Syn.—July 3, CPMs—July 13)

AIEE-IRE Magnetic Amplifiers Conference
Shoreham Hotel
Washington, D. C.
September 23-25, 1959
(Final date for †TP—June 22, ‡CP Syn.—July 10, CPMs—July 20)

AIEE-ASME National Power Conference
Muehlebach Hotel
Kansas City, Mo.
September 30-October 2, 1959
(Final date for †TP—July 2, ‡CP Syn.—July 17, CPMs—July 27)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 11-16, 1959
(Final date for †TP—June 12, ‡CP Syn.—July 30, CPMs—Aug. 7)

National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 12-14, 1959
(Final date for †TP—July 14, ‡CP Syn.—July 28, CPMs—Aug. 7)

Machine Tools Conference
Hotel Cleveland
Cleveland, Ohio
October 19-21, 1959
(Final date for †TP—July 21, ‡CP Syn.—Aug. 4, CPMs—Aug. 14)

AIEE-IRE-ISA National Automatic Control Conference
Sheraton Hotel
Dallas, Tex.
November 4-6, 1959
(Final date for summaries—June 1)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

**Transactions and conference papers must conform to the requirements in *Authors Guide*.
For a copy, write to E. C. Day AIEE, 33 W. 39th St., New York 18, N.Y.**

(Continued from p. 248)

Technical Program

The tentative technical program for the District Meeting follows:

Tuesday, April 7

AIEE Executive Session, District Executive Committee

Wednesday, April 8

8:30 a.m. Registration—Dinkler Plaza lobby

9:30 a.m. General Session

Introduction: R. G. Elliott, general chairman, vice-president, Southern Bell Telephone & Telegraph Co.

Welcome Address: Mayor W. B. Hartfield

Introduction of AIEE President L. F. Hickernell

Address: Dr. E. D. Harrison, president, Georgia Institute of Technology

12:00 a.m. General Luncheon

Presiding: R. G. Elliott

Address: Dr. Pierce Harris, pastor, First Methodist Church

Presentation of Fellow Diploma to C. B. MacManus

2:00 p.m. Power Generation—Mirror Room

Presiding: A. H. Mergenthaler, Southern Services Inc.

Oliver Dam Hydro Plant. *R. J. Kelley,* Georgia Power Co.

D-C Overpotential Testing as a Maintenance Tool in Industrial Plants. *W. A. Weldendorf,* Mutual Boiler and Machinery Ins. Co.

New Design Metalclad Switchgear for 4.16-Kv Service. *N. Kreekon.* Allis-Chalmers Manufacturing Co.

High Capacity Busses; Design, Testing, and Field Experience. *G. E. Buchanan,* H. K. Porter Co.

2:00 p.m. Industrial Power System—Sky Room

Presiding: E. R. Felton, Esso Standard Oil Co.

Maintaining Reliable Relay Settings. *B. E. Crawford,* Esso Standard Oil Co.

Current Limiting Fuses. *H. D. Kurt, T. Brandt,* General Electric Co.

Power for the Missile Age. *J. J. Berry,* Smith & Gillespie Engineers.

Grounding Installations for Industrial Power Systems. *H. V. Poe,* Clemson College.

2:00 p.m. Material Handling—Dinkler "A"

Presiding: E. M. Murphy

Loading Dock Operations for Airlines. *W. L. Brown,* Lockheed Aircraft Corp.

Application of Reactor Control to Material Handling Equipment. *H. A. Zollinger,* Westinghouse Electric Corp.

Modern Approach to Material Handling Problems. *W. D. Stoddart,* Link Belt Co.

Material Handling in Paper Industry. *J. F. Steedley,* Bowaters Engineering & Development Co.

2:00 p.m. Management—Roof

Presiding: Dr. W. J. Seeley, Duke University.

Presentation of Management Game. *Dr. W. R. Atchison,* Georgia Institute of Technology

An Approach to the Management Orientation of New First Level Supervisors of Professional People. *W. J. Paxton,* Westinghouse Electric Corp.

Human Relations as a Fad, Fraud, and Fact of Life. *Dr. H. R. Smith,* University of Georgia

General Management Developmental Programs. *G. W. Porter,* Southern Bell

Thursday, April 9

9:00 a.m. Industrial Control—Mirror Room

Presiding: D. F. Chappell, S. J. Reynolds Tobacco Company

Automatic Programming of Industrial Control. General Electric Co.

Punch Tape Control for Milling Machines. *J. Albert,* Lockheed Aircraft Corp

Servo Feedback of Electric Stick. *D. Gunson,* Lockheed Aircraft Corp.

Static Switching Devices. *A. K. Ramsey,* Louisiana State University

9:00 a.m. Computers—Sky Room

Presiding: W. J. McKune, Georgia Institute of Technology

Use of Computers in Distribution System Design. *S. C. Mewborn,* Southern Engineering Co.

Use of Computers in Preparation of Load Data for A-C Analyzer Studies. *M. O. Richter,* Georgia Power Co.

Electronic Computers in Engineering. *C. R. Murton,* Southern Services Inc.

A New Direct Matrix Inversion Method. *R. B. Shipley, Dorothy Coleman,* TVA

9:00 a.m. Atomic Power in the Southeast—Dinkler "A"

Presiding: L. C. Moore, Westinghouse Electric Corp.

Carolinas-Virginia Power Reactor. *W. N. Thomas,* Carolina-Virginia Nuclear Power Association; *A. R. DelCamp, A. R. Jones,* Westinghouse Electric Corp.

Atomic Power in the S.E.—Education and Research. *Dr. W. B. Harrison,* Georgia Institute of Technology

Electrical Engineering in Atomic Powered Aircraft. *C. W. Holland,* Lockheed Aircraft Corp.

Nuclear Submarines. *Capt. P. K. Taylor,* U.S. Navy

9:00 a.m. Radio Communications—Plaza "B"

Presiding: J. M. Street, Jr., Southern Bell

Channelization of Radio. *W. D. Baker, J. W. Joyner,* Southern Bell

Circular Polarization Duplexer for Millimeter Waves. *R. G. Fellers,* University of South Carolina

The Telephone Industry's Part in Air Defense Communications. *W. A. Russey,* Southern Bell

2:00 p.m. Mining, Chemical, and Petroleum Industry—Plaza "B"

The Application of Large Synchronous Motors for Gas Transmission. *M. A. Hyde, D. C. Washburn,* Westinghouse Electric Corp.

2:00 p.m. Transmission and Distribution—Mirror Room

Presiding: T. J. Allen, Georgia Power Company

Control of Switched Capacitors in Distribution Substations. *J. D. Huddelston,* Georgia Power Co.

Methods of Extending Usefulness of Air Brake Switches. *E. C. Ranker,* Appalachian Power Co.

Economic Advantage of SRT Distribution Transformers. *A. R. Waehner,* Line Material Co.

2:00 p.m. Continuing Education for Engineers—Sky Room

Presiding: W. J. Miller, University of Alabama

Engineering Training in an Operating Telephone Company. *W. L. Sullivan,* Southern Bell

A New Approach to Training Telephone Engineers. *W. C. Burnett,* Southern Bell, *Dr. L. C. Adams,* Savannah River Project

Nuclear Reactor Engineering Course. *H. H. Strozier,* Georgia Power Co.

DURING the AIEE Joint District Meeting, an inspection trip will be made to Owens-Illinois Container Plant. Here a forming machine operator puts an experienced eye on a newly formed gallon jug, which has just been automatically blown into an iron mold. Containers move by conveyor to an annealing oven, or lehr, and then are inspected again before packing.

Lockheed Engineering Training Course. *R. H. Hudson,* Lockheed Aircraft Corp.

2:00 p.m. Wire Communications—Dinkler "A"

Presiding: W. C. Burnett, Southern Bell

Transposition System for Compandored Multichannel Open Wire Carrier Systems. *Mrs. Bess Kirkland,* Southern Bell

Bonding and Isolation of Telephone Cable. *D. A. Greer,* Southern Bell

Buried Polyethylene Insulated Cable for Intercity Toll Use. *F. G. Taylor,* Southern Bell

E-3 Repeater Application. *J. W. Joyner,* Southern Bell

Friday, April 10

9:00 a.m. Cathodic Protection—Mirror Room

Presiding: J. L. Gray, Louisville Gas & Electric Company

Deep Ground Beds for Use with Cathodic Rectifiers. *D. L. Berryhill,* Southern Bell

Corrosion Problem in Jacksonville, Fla. *G. D. Boggs,* Southern Bell

Cathodic Protection. *S. E. Trouard, E. A. Wagner,* New Orleans Public Service

9:00 a.m. Transformers and Rotating Machinery—Sky Room

Presiding: R. O. Loomis, Georgia Power Co.

Principles of Design, Application, and Operating Record of LTC Equipment. *G. A. Wilson,* Pennsylvania Transformer Co.

Evaluation of Various Types of Electric Motor Insulation. Allis-Chalmers Manufacturing Co.

Unique Two-Piece Stator for Small, Low Inertia Servo-motors. *E. J. Moore,* Wright Machinery Co.

9:00 a.m. Instrumentation—Dinkler "A"

Presiding: M. G. Myers, Westinghouse Electric Corp.

In Flight Recording—Test of Systems. *J. Jamgochian, T. K. Spear,* Lockheed Aircraft Corp.

The Electrical Engineer in Chemical Process Instrumentation. *G. Alford,* Chemstrand Corp.

Instrumentation and Process Control. *W. R. Mickelson,* General Electric Co.

Instrumentation in the Kraft Board Paper Industry. *K. A. Riddle,* Rome Kraft Paper Co.

9:00 a.m. Basic Science—Plaza "B"

Presiding: E. S. Lammers, University of Florida

Symposium on Nuclear Radiation Protection. *Dr. J. T. Wilson,* Louis Allis Co., moderator; *H. H. Strozier,* Georgia Power Co.; *Dr. M. M. Miller,* Lockheed Aircraft Corp.; *Dr. L. C. Adams,* Savannah River Project

Thermo-Electricity. *J. C. R. Kelley, S. J. Angelo,* Westinghouse Electric Corp.

Recent Advance in Magnetic Tape. *J. L. Kamefke,* M.M.M. Co.

2:00 p.m. Automatic Load and Frequency Control—Mirror Room

Presiding: W. R. Brownlee, Southern Services Inc.

Reliability, the Keynote in Automatic Dispatching Equipment Design. *R. L. Tremaine,* Westinghouse Electric Corp.

Experience with ADS on San Antonio System. General Electric Co.

Modern Trends in Load Frequency Control. *W. S. Bloor,* Leeds and Northrup

2:00 p.m. Design for Maintenance—Plaza "B"

Design for Maintainability—Philosophy of. *H. R. Nuce,* Lockheed Aircraft Corp.

Design for Maintainability—Application of. *H. R. Nuce,* Lockheed Aircraft Corp.

Radio Circuitry-Design for Maintenance. *J. Hunt,* Collins Radio Co.

Student Papers—Roof

Student papers will be presented on Wednesday, 9:00 a.m.; Thursday, 9:00 a.m.; and Friday, 9:00 a. m.

Professor Weston

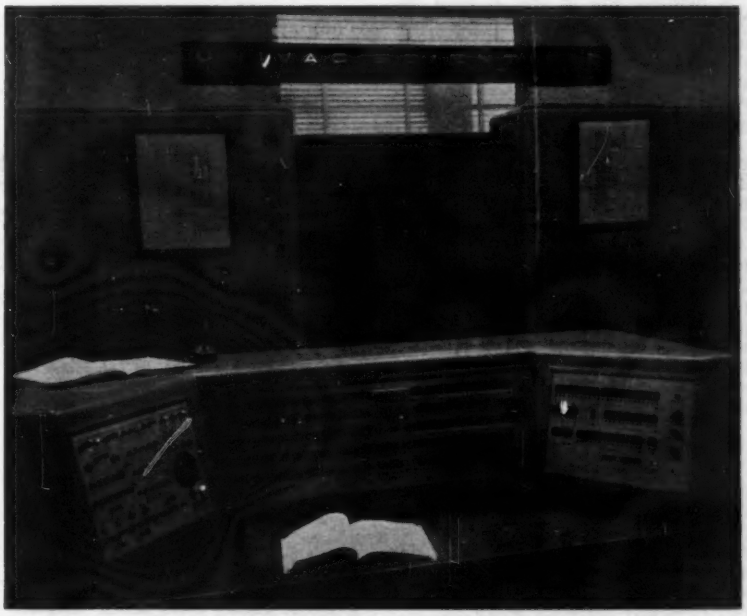
Computer Registration Techniques To Be Featured at District Meeting

AIEE MEMBERS attending the Joint District Meeting of Districts No. 4 and No. 13 in Atlanta, Ga., April 8-10, 1959, will witness and participate in a unique application and demonstration of high-speed data handling using a digital computer. Registration data on each attendee will be fed into the memory of a computer and it will provide rosters and hotel locations of attendees, numbers and rosters of those who are expected to attend the various field trips and social events, separate lists of students, wives, and guests and other pertinent data.

Information between the meeting headquarters in the Dinkler Plaza Hotel and the computer on the Georgia Institute of Technology campus will be carried over telephone lines supplied by the Southern Bell Telephone & Telegraph Co. Input and output at the hotel will be by electric typewriter. Closed-circuit television will enable viewers at the hotel to observe the computer in operation.

In addition to the registration data which will be compiled by the computer, the computer will be available for interrogation by the attendees at the hotel. It will provide information as to individual attendees' hotel location and attendance at various events. It will also provide the latest weather forecasts, baseball scores, and other vital information and will be used to replace the bulletin board customarily used for messages between attendees. Such a message will be fed into the machine, which will then provide a list of names of those for whom there are messages and will produce the message via the typewriter upon request of the addressee. It will also be used to supply certain statistical information as to the ages, marital status, number of children, and distance traveled by the attendees.

Heart of the system will be the Univac Scientific *(ERA 1101),* a large-scale high-speed stored program electronic computer at the Rich Electronic Computer Center



COMPUTER REGISTRATION TECHNIQUES will be a feature of the AIEE Joint District Meeting to be held in Atlanta, Ga., April 8-10, 1959. Heart of the system will be the Univac Scientific (ERA 1101) a large-scale high-speed stored program electronic computer at the Rich Electronic Computer Center on the Georgia Institute of Technology campus.

on the Georgia Tech campus. The data will be stored in binary form on the 16,384 word magnetic drum and 4,096 word magnetic core storage unit. Information from the hotel lobby will produce punched paper tape at the computer location which will be fed into the computer. Information from the computer will come directly to the typewriter at the hotel lobby. The distance between the two locations is approximately 2 miles.

The system is being co-ordinated by three senior electrical engineering students at Georgia Tech, N. G. Heller, R. A. Eason and Patrick Flautt, under the direction of Dr. W. J. McKune.

Conference Will Cover "New Horizons with Computer Technology"

THE 1959 Western Joint Computer Conference, sponsored by AIEE, Institute of Radio Engineers (IRE), and Association for Computing Machinery (ACM), will be held March 3-5, at the Fairmont Hotel in San Francisco, Calif.

Registration

There will be no advance registration for the Conference. Fees are: $6, members; $7, nonmembers; $2, students. All registration will take place at the Fairmont Hotel: March 2, 6:00 p.m. to 9:00 p.m.; March 3-4, 7:30 a.m. to 5:00 p.m.; March 5, 7:30 a. m. to 1:00 p.m.

Exhibits

Exhibits, which will be located in the Fairmont Hotel (Nob Hill, Gold, Empire, Green, and Garden Rooms), will be open at the following hours: March 3, 12:00 Noon to 6:00 p. m.; March 4, 12:00 Noon to 9:00 p.m.; March 5, 9:00 a.m. to 6:00 p.m.

Social Activities

A luncheon will be held at noon on March 4 in the Tonga Room of the Fairmont at which the speaker will be Col. D. E. Ellett, chief of the Data Systems Plans Division, Directorate of Plans and Programs, Air Materiel Command. The fee will be $4.

The "Harbor Queen" will leave from Fisherman's Wharf at 5:30 p.m. on Tuesday, March 3, on a cruise of San Francisco Bay. There will be cocktail service aboard. Fee will be $5 per person.

Several activities have been arranged for the ladies during the Conference, including a special tour of the Matson Liner "Matsonia"; luncheon and fashion promenade in the tropical terrace of the Hotel Canterbury; talk by Dr. H. R. J. Grosch, "Never Underestimate the Power of Computers," Fairmont Hotel; and a bus tour of San Francisco.

Field Trips

Field trips planned during the Conference will include visits to: University of California Radiation Laboratory, Berkeley (Wednesday afternoon, March 4); Philco Corporation Western Development Laboratories, Palo Alto (Wednesday evening, March 4); Ampex Corporation, Redwood City (Thursday afternoon, March 5).

Proceedings

A copy of the Conference Proceedings will be sent to each registrant. The cost is included in the registration fee. Persons unable to attend may obtain copies upon publication by payment of appropriate registration fee. Write to: R. M. Bennett, Jr., P.O. Box 381, Station A, Palo Alto, Calif.

Committee

General officers and committee chairmen for the Conference include: R. R. Johnson, general chairman; R. W. Melville, vice-chairman; H. G. Asmus, secretary-treasurer; R. W. Melville, technical program; B. J. Bennett, publications; G. A. Barnard, III, publicity; H. K. Farrar, exhibits; K. F. Tiede, field trips; R. M. Bennett, Jr., registration; I. D. Krider, printing; Mrs. Joanne Teasdale, women's activities; R. C. Douthitt, local arrangements; E. T. Lincoln, mailing.

Technical Program

The tentative technical program for the Conference follows.

Tuesday, March 3

9:00 a.m. Session I-A New Components and Circuits

Chairman: C. L. Wanlass, Aeronutronic Systems, Inc.

A Multiload Transfluxor Memory. *D. G. Hammel, W. L. Morgan, R. D. Sidnam,* Radio Corporation of America (RCA)

Design and Analysis of Transfer Circuitry. *D. R. Bennion, H. D. Crane,* Stanford Research Institute

A Magnetic Matrix Memory for Semipermanent Information. *D. H. Looney,* Bell Telephone Laboratories

Card Changeable Nondestructive Readout Twistor Store. *J. Janik, Jr., J. J. DeBuske, B. H. Simons,* Bell Telephone Laboratories

Square Loop Magnetic Logic Circuits. *E. P. Stabler,* General Electric Company (GE)

9:00 a.m. Session I-B Information Retrieval and Machine Translation

Chairman: C. Bourne, Stanford Research Institute

Relative Merits of General Purpose and Special Purpose Computers as Used for Information Retrieval. *A. Opler, N. Baird,* Computer Usage Co., Inc.

A Special Library Index Search Computer. *B. Kessel,* Computer Control Co., Inc.; *A. DeLucia,* Rome Air Development Center

Programmed Interpretation of Text as a Basis for Information Retrieval Systems. *L. Doyle,* System Development Corp.

A Theory of Information Retrieval. *C. Walker,* Hughes Aircraft Company

The Role of USAF Research and Development in Information Retrieval and Machine Translation. *R. Samson,* Rome Air Development Center

2:00 p.m. Session II-A Computer Communication

Chairman: H. C. Martel, California Institute of Technology

Simulation of an Information Channel on the IBM *704* Computer. *E. G. Newman, L. O. Nippe,* International Business Machines Corporation (IBM)

A Compiler with an Analog-Oriented Input Language. *M. L. Stein,* University of Minnesota; *Jack Rose, D. B. Parker,* Convair-Astronautics

Automatic Design of Logical Networks. *T. C. Bartee,* Massachusetts Institute of Technology

The Role of Digital Computers in the Dynamic Optimization of Chemical Reactions. *R. E. Kalman, R. W. Koepcke,* IBM

Simulation of Human Problem Solving. *W. G. Bouricius,* IBM

2:00 p.m. Session II-B Education and Methodology for Use of Computers

Chairman: G. W. Brown, University of California at Los Angeles

The Role of the University in Computers, Data-Processing and Related Fields. *L. Fein,* Consultant, Palo Alto, Calif.

The RCA *501* Assembly System. *H. Bromberg, T. M. Hurewitz, K. Kozarsky,* RCA

A Program To Draw Multilevel Flow Charts. *L. M. Haibt,* IBM

A Compiler Capable of Learning. *R. Arnold,* Michigan State University

Wednesday, March 4

9:00 a.m. Session III-A Achieving Reliability in Operation Control

Chairman: L. Fein, Consultant, Palo Alto, Calif.

Special Purpose Electronic Data Systems. *M. V. Crowley,* RCA

The Residue Number System. *H. L. Garner,* University of Michigan

System Evaluation and Instrumentation for Military Special Purpose Digital Computer Systems. *A. J. Strassman, L. H. Kurkjian,* Hughes Aircraft Company

Automatic Failure Recovery in a Digital Data Processing System. *R. H. Doyle, R. A. Meyer, R. P. Pedowitz,* IBM

9:00 a.m. Session III-B Learning Concepts and Pattern Analysis.

Chairman: P. Suppes, Stanford University

Some Experiments in Machine Learning. *H. Campaigne,* American University

Some Communication Aspects of Character Sensing Systems. *C. C. Heasly, Jr.,* Intelligent Machines Research Corp.

An Approach to Computers that Perceive, Learn, and Reason. *P. H. Greene,* University of Chicago

2:00 p.m. Session IV-A New Machines and Systems

The RCA *501* High-Speed Printers—The Story of a Product Development. *C. Eckel, D. Flechtner,* RCA

A Digital Computer for Industrial Process Analysis and Control. *E. L. Braun,* Genesys Corporation

The Burroughs *220* High-Speed Printer System. *F. Bauer,* Electrodata

The Acre Computer—A Digital Computer for a Missile Checkout System. *R. I. Tanaka,* Lockheed Aircraft Corporation

The IBM *7070* Data Processing System. *J. Svigals,* IBM

2:00 p.m. Session IV-B Computer Applications in Business Environments

Chairman: R. R. Crane, Touche, Niven, Bailey & Smart, Detroit

An Organizational Approach to Electronic Data Processing. *G. Fleming,* Boeing Airplane Company

Developing a Long-Range Plan for Corporate Methods and the Dependence on Electronic Data Processing. *N. J. Ream,* Lockheed Aircraft Corporation

A Long-Range Electronic Data Processing Plan for a National Multiplant Manufacturing Company. *G. Redmond,* Chrysler Corporation

Dynamic Production Scheduling of the Job Shop Operation. *L. N. Caplan, V. L. Schatz,* GE

Thursday, March 5

9:00 a.m. Session V-A Numerical Analysis

Chairman: R. D. Levee, University of California Radiation Laboratory

Survey of Numerical Analysis. *G. E. Forsythe,* Stanford University

More Accurate Linear Least Squares. *R. Von Holdt,* University of California Radiation Laboratory

The Cordic Computer (A set of three papers)
The Cordic Transcendental Computing Technique. *J. E. Volder,* Convair

Implementation of Co-ordinate Rotation and Other Trigonometric Function Algorithms by Cordic. *D. R. Clutterham,* Convair

Decimal-Binary Conversions in Cordic. *D. H. Daggett,* Convair

Monte Carlo Techniques Applied to Statistical Mechanics. *W. W. Wood,* Los Alamos Scientific Laboratory

Real-Time Digital Analysis and Error Compensating Techniques *W. Ito,* Minneapolis-Honeywell Regulator Company

Automatic Digital Matric Structural Analysis. *B. Klein, M. M. Chirico,* Convair

Problems of the Future. *S. Ulman,* Los Alamos Scientific Laboratory

9:00 a.m. Session V-B "Blue Sky" Session

Chairman: L. N. Ridenour, Lockheed Aircraft Corporation

A New Approach to High-Speed Logic. *W. D. Rowe,* Westinghouse Electric Corporation

Experiments in Information Retrieval. *R. Cochran,* GE

Communication Across Language Barriers. *W. F. Whitmore,* Department of the Navy, Washington, D. C.

Symbolic Language Translation. *E. C. Gluesing,* Remington Rand

New Horizons in Computer Technology. *H. Aiken,* Harvard University

2:00 p.m. Session VI-A New Applications of Computer Technology

Chairman: H. D. Huskey, University of California

A Generalized Scanner for Pattern and Character Recognition Studies. *W. H. Highleyman, L. A. Kamentsky,* Bell Telephone Laboratories

File Searching Using Variable Length Keys. *R. De La Briandais,* U. S. Naval Ordnance Laboratory

Program Design To Achieve Maximum Machine Utilization in a Real-Time Computing System. *A. F. Rosene,* Sylvania Electric Products, Inc.

Pattern and Character Recognition Systems—Picture Processing by a Net of Neuron-Like Elements. *L. A. Kamentsky,* Bell Telephone Laboratories

2:00 p.m. Session VI-B Philosophy and Responsibility of Computers in Society

Chairman: R. W. Tyler, Center for Advance Study in the Behavioral Sciences, Stanford

Social Responsibility of Engineers. *F. Wood,* IBM

Emergency Simulation of the President of the United States. *L. Sutro,* Datamatic

Can Computers Help Solve Society's Problems. *J. Rothstein,* Edgerton, Germeshausen & Grier, Inc.

Measurement of Social Change. *R. L. Meier,* University of Michigan

2:00 p.m. Session VII Analog Simulation

Chairman: J. E. Sherman, Lockheed Aircraft Corporation

Simulation of Sampled Data Systems Using Analog-to-Digital Converters. *M. S. Shumate,* Space Technology Laboratories, Ramo-Wooldridge Corp.

A Transistorized Analog Memory for Functions of Two Variables. *P. C. Sherertz, L. E. Steffen,* Convair

A Time-Sharing Analog Computer. *J. V. Reihing, Jr.,* Westinghouse Electric Corporation

CP59-230. Computers—The Answer to Real-Time Flight Analysis. *G. Hintze,* chief, Flight Simulation Laboratory, White Sands Missile Range

Special Sessions

Tuesday, March 3

9:00 a.m. Special Session A. Industry's Role in Supporting High School Science Programs

Chairman: Dr. Paul Hurd, associate professor of education, Stanford University

2:00 p.m. Special Session B (Extra Session of Session I-B). Information Retrieval and Machine Translation

Chairman: C. Bourne, Stanford Research Institute

Computing Educated Guesses. *E. S. Spiegelthal,* GE

A Memory of 314 Million Bits Capacity with Fast and Direct Access—Its Systems and Economic Considerations. *N. Bishop,* Time, Inc.; *A. Dumey,* consultant

Information Retrieval on a High-Speed Computer. *A. Barton, V. Schatz, L. Caplan,* GE

The Next 20 Years in Information Retrieval: Some Goals and Predictions. *C. N. Mooers,* Zator Company

Wednesday, March 4

9:00 a.m. Special Session C. Military Applications

Chairman: H. Silverstein, Department of the Army, Washington, D. C.

Drafting Digital Computers into Tactical Combat. *Capt. A. B. Crawford, Jr.,* Fort Huachuca, Ariz.

Data Transmission Equipment Concepts for FIELDATA. *Capt. W. F. Luebbert,* Fort Monmouth, N. J.

A High-Accuracy, Real-Time Digital Computer. *W. J. Milan-Kamski,* EPSCO

The Man-Computer Team in Space Ecology. *J. McLeod,* Convair; *J. Stroud,* Navy Electronics Laboratory

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EJC Presents Citation for Encouragement of Science Education

AT A LUNCHEON MEETING of the Board of Directors of Engineers Joint Council (EJC), held in the Hotel Roosevelt, January 16, 1959, EJC presented a citation to the Westinghouse Educational Foundation and the Carnegie Institute of Technology for conducting the George Westinghouse Scholarship Program, one of the first national scholarship programs to encourage science education. The luncheon was held during an all-day open meeting of the Board of Directors of EJC. After the ceremonies, an address, "Engineering, the Policies and Program in the National Science Foundation," was delivered by Dr. R. D. Brode, associate director of the National Science Foundation (NSF).

The presentation of the citation recognizing the 20th Anniversary of the Scholarship Program was made by EJC President E. R. Needles, who said, "It is particularly fitting at a time when our nation faces increased responsibilities in its technological progress, that Engineers Joint Council recognized two of the leading organizations which over the past two decades have helped to supply our educational institutions, industry, and Government with well-trained minds in the technical fields. Not the least of the contributions, which the Westinghouse Educational

DR. B. R. TEARE (*left*), dean of engineering and science at the Carnegie Institute of Technology; Dr. J. A. Hutcheson (*center*), chairman of the Westinghouse Educational Foundation and vice-president in charge of engineering for Westinghouse Electric Corporation, receive, on behalf of their respective institutions, a citation from EJC President E. R. Needles (*right*). The citation recognizes the 20th Anniversary of the establishment of the George Westinghouse Scholarship Program. The presentation of the citation took place January 16, 1959, at a luncheon meeting of the Board of Directors of EJC which was held at the Hotel Roosevelt in New York City.

Foundation and the Carnegie Institute of Technology have made is to focus our attention annually to the importance of an engineering and science career."

The citation presented at the meeting read as follows:

> "For their vision in recognizing the need to encourage talented young minds to seek careers in engineering, science, and management and, to this end, for the establishment of the George Westinghouse Scholarship Program, twenty years ago, the first such national scholarship program;
>
> For establishing a pattern of scholarship help in engineering and scientific education which has provided many of the nation's key industries and Government agencies with young men and women of outstanding caliber in their fields;
>
> For helping to enable brilliant minds to pursue higher education in engineering and science which otherwise would have been lost to the nation.
>
> Therefore, Engineers Joint Council takes this occasion, at the meeting of its Board of Directors on January 16, 1959, to publicly commend the Westinghouse Educational Foundation, the Carnegie Institute of Technology and the Westinghouse Electric Corporation (which provides support for the program), on behalf of its twenty constituent engineering, educational, and scientific societies, representing 300,000 of the nation's engineers. Engineers Joint Council expresses its hope that the George Westinghouse Scholarship Program will continue to be a vital force in engineering education and may serve as an example for many other organizations to follow."

The citation was accepted by Dr. J. A. Hutcheson, chairman of the Westinghouse Educational Foundation, on behalf of the Westinghouse Electric Corporation, and B. R. Teare, Jr., dean of engineering and science, on behalf of the Carnegie Institute of Technology.

In acceptance, Dr. Hutcheson outlined a new program in which laboratory equipment will be offered free to all of the nearly 150 accredited electrical engineering departments of colleges and universities in the United States. The new equipment can be used to teach student engineers the basic principles of converting mechanical energy to electric energy and vice versa. It will consist of two fractional horsepower drive motors, two tachometers, a torque meter and a specialized rotating device that can be operated either as a motor or a generator. With all this apparatus working on a single shaft, the specialized unit can be operated as a generator driven by two motors. Used as a motor, it can drive the rest of the equipment, including the two fractional horsepower motors. Thus, it will be possible to duplicate any situation involving rotating electric machinery and to study the static as well as the dynamic characteristics of converting mechanical energy to electric or converting electric energy to mechanical.

National Science Foundation

The role of the NSF in administering grants of funds for the support of basic scientific research was explained by R. D. Brode, associate director. Basic scientific research was defined as a systematic, intensive study directed not to a practical application but rather toward a fuller scientific knowledge of the subject. Proposals are assigned to program directors on the basis of their special competence and interests and the appraisal of each proposal is made by panels and consultants who consider the following: (1) the qualifications of the investigators, (2) the nature and merit of the project, and (3) the contribution that the sponsoring institution can make to the project. From about $20 million that the NSF received this year to support physical sciencies, about $3 million is allotted to support basic research in engineering. The NSF is seeking to meet a larger per cent of the support that is requested of it.

As explained by the speaker, an appropriate measure for satisfactory distribution of the grants would appear to be the number of graduate students in science. The northeast United States, with 38% of the graduate science students, gets 36% of the grant. The north central, with 25% of the graduate students, gets 29% of the grant. The south, with 19% of the students, gets 16% of the grant, and the west, with 18%, gets 19% of the grant's support in dollars. The largest institutions give 63% of all graduate degrees, have 53% of the nation's science faculty that are engaged in research, and they have received 68% of the NSF's grant funds. Students and faculties interested in applied research will find much larger funds available from the Government than are available for basic research.

In conclusion, Dr. Brode referred to the serious shortage of assistant professors at the Ph.D. level for basic research work. He likened the situation, on the one hand, to a system with a built-in feedback—a bad situation tends to get worse. There is, however, on the other hand, the corresponding reward in that improvement tends to encourage further improvement, which makes future prospects far from hopeless. The Federal Government is very much concerned with the successful solution of the problems ahead in engineering education since our international position as a leader in technology is dependent on the quality of our technical education. In the area of basic science as it supports technical education and research, the NSF will continue to seek the funds that are needed for this essential program.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

"For Mankind's Progress" Will Be Theme of 1959 Nuclear Congress

DETAILS of the 1959 Nuclear Congress, the nation's largest gathering of specialists in the atomic field, were announced recently. Some 40 sessions are to be held during the 5-day Congress, April 5-10, at the Public Auditorium in Cleveland, Ohio.

This year's Nuclear Congress is an assembly of the 7th Hot Laboratories and Equipment Conference, 5th Nuclear Engineering & Science Conference, 7th Atomic Energy Management Conference, and the trade show, Atomfair.

The Congress announcement noted that invitations had been issued to Soviet engineers to describe details of their power reactor program, including a 600,000-kw power plant reported to be under construction in Siberia.

During the meeting, Sir Claude Gibb, managing director of one of England's leading nuclear development firms, C. A. Parsons, Ltd., will address a luncheon meeting. Other speakers from abroad include specialists from England, France, and Italy.

Theme of the Congress, which will be sponsored by more than 30 leading engineering, scientific, and management groups, including AIEE, is "For Mankind's Progress."

Advance Registration

Registration fees are as follows: 5th Nuclear Engineering & Science Conference—$15; 7th Hot Laboratories and Equipment Conference—$20 (includes Proceedings); All Congress Banquet (7 p.m., Hotel Sheraton-Cleveland)—$12 per plate. Checks should be made payable to: 1959 Nuclear Congress, and mailed to: 1959 Nuclear Congress, Architects Building-Room 310, 117 South 17th St., Philadelphia 3, Pa.

Those mailing in registration fees should include the following information: name, company, address, society membership. Cancellations of registration fee and tickets will be accepted until March 30. No refunds will be made thereafter.

Badges and tickets for the Nuclear Engineering & Science Conference and the Hot Laboratories and Equipment Conference will be held at the Registration Desk, Public Auditorium, Cleveland.

Hotel Reservations may also be requested by mail for the following hotels: Auditorium, Pick-Carter, Sheraton-Cleveland, Hollender, Manger, Statler-Hilton, Olmstead. Include arrival and departure dates and type of accommodations desired. Do not enclose check for hotel reservations.

Congress Highlights

Highlights of the Congress include the following events:

Monday, April 6, 12:00 Noon—AIEE Lunch.

Tuesday, April 7, 12:00 Noon—American Institute of Chemical Engineers Lunch; speaker: Dr. Arthur Compton, Washington University.

Tuesday, April 7, Evening—Hot Laboratories Reception.

Wednesday, April 8, 12:00 Noon—American Society of Mechanical Engineers Lunch; speaker: Sir Claude Gibb, C. A. Parsons, Ltd., England. American Society for Engineering Education Lunch.

Wednesday, April 8, Evening—All Congress Banquet.

Thursday, April 9, 12:00 Noon—American Nuclear Society Lunch; speaker: Dr. Miles Leverett, General Electric Company.

Hot Laboratories and Equipment Conference

The 7th Hot Laboratories and Equipment Conference will include sessions on: hot laboratories and facilities, general manipulative equipment, viewing, cell fixtures and specialized manipulative equipment, gamma irradiation facilities, operations and techniques, problems in simultaneous handling of alpha- and gamma-emitting materials, and a round table discussion of operational problems.

Atomic Energy Management Conference

Sponsored by the Atomic Industrial Forum, the Atomic Energy Management Conference will hold morning and afternoon sessions on Wednesday, Thursday, and Friday, April 8, 9 and 10.

The Conference consists of a series of discussions on the board application of nuclear power and its influence, and the potential effect of the nuclear field on the sociological and economic structure of industry.

Atomfair

The Atomfair hours are from 9:00 a.m. to 5:00 p.m. from April 6 through April 10.

The Atomfair is an exhibit by major manufacturers of the latest products, components, and services for the peaceful use of atomic energy. Those visiting the Atomfair will have an opportunity to discuss problems and needs with top factory representatives of the leading suppliers in the nuclear industry. This exposition is beng held in conjunction with the technical sessions of the Nuclear Congress at the Municipal Auditorium. Persons registering for any conference will automatically be admitted to the Atomfair.

Nuclear Engineering & Science Conference

The tentative program for the Nuclear Engineering & Science Conference follows.

Monday, April 6

9:30 a.m. Waste Disposal

Evaluation of the Initial Performance of the Shippingport Radioactive Waste Disposal Plant. *J. R. Lapointe, W. J. Hahn, E. D Harward,* Westinghouse Electric Corp.

Development of Design Principle for Disposal of Reactor Fuel Waste into Underground Salt Cavity. *Shosei Serata, E. F. Gloyna,* University of Texas

Proportional Sampling of Flowing Liquid Wastes for Radioactivity Monitoring. *J. M. Ruddy,* Brookhaven National Laboratory

Thermal Considerations in the Storage of Radioactive Wastes in Salt Formation. *R. S. Schechter, E. F. Gloyna,* University of Texas

Disposal of Radioactive Liquids from Nuclear Powered Ships. *J. M. Smith, Jr.,* General Electric. San Jose, Calif.

The Need for Biological Monitoring of Radio-Active Waste Streams. *R. F. Foster,* General Electric—Hanford Laboratories.

9:30 a.m. Nuclear Research Test and Training Facilities

Radiological Health Training for Personnel Responsible for Water Quality. *D. W. Moeller, D. A. Pecsok, H. P. Kramer,* Robert A. Taft Sanitary Engineering Center

Design Considerations for an In-Pile Loop. *C. A. Baumgartner,* Curtiss-Wright Corp.

Comparative Study of Test Facilities—Aircraft Propulsion Systems. *E. G. Johnson,* Marquardt Aircraft

The University of Florida Training Reactor. *J. M. Duncan,* University of Florida

The Army Training Program for Nuclear Power Plant Personnel. *Lt. W. Eager, Capt. D. King, Capt. J. LaFleur*

Design and Construction Features of the General Electric Test Reactor. *K. Dreher, M. J. Larocco,* Ralph M. Parsons Co.

9:30 a.m. Simulation and Experimental Instrumentation

Instrumentation for the Reactor Transient Study Program of the KEWB Reactor. *E. L. Gardner, J. W. Flora, Lt. R. K. Stitt, R. E. Wimmer,* Atomics International

Critical Experiment Safety Systems with Electrometer-Type Operational Amplifiers. *Russell Ball,* Babcock & Wilcox Co.

Simulation of the EBWR for the Geneva Conference. *R A. Brey,* Leeds & Northrup Co.

Transistorized Computers for Naval Reactor Nuclear Instrumentation Systems. *Warren Alexander,* Stromberg-Carlson Co.

Approximate Solutions to the Reactor Kinetic Equations for Ramp Inputs. *John MacPhee,* AMF Atomics

A Low-Cost Nuclear Power Plant Simulator. *C. C. Scott,* Minneapolis-Honeywell Regulator Co.

2:15 p.m. Water Supply

Development of Emergency Procedures in Case of an Accidental Discharge of Liquid Radioactive Wastes from a Nuclear Reactor. *E. D. Harward,* AEC-Pittsburgh Naval Reactor Operations Office

The Measurement, Building Penetration, and Water Filter Passage of Radioactivity. *C. G. Bell Jr.,* Oak Ridge National Laboratory

Concepts in Determining the Potability of Water Following a Nuclear Attack. *Gerhard Klein,* University of California

Assembly and Operation of Low-Level Counting Facility. *G. R. Hagee,* Robert A. Taft Sanitary Engineering Center

Radioactivity in Water—Environmental Surveillance. *H. P. Kramer, D. W. Moeller, D. A. Pecsok,* Robert A. Taft Sanitary Engineering Center

2:15 p.m. Nuclear Instruments

Design and Development of 600 F Pulse Pre-Amplifier for Nuclear Instrumentation. *W. L. Frisby, E. M. Palmer,* General Electric Co., Burlington, Vt.

A Dual-Channel Reactor Protection System for Nuclear Power Plants. *A. S. Bartu,* General Electric Co., San Jose, Calif.

Analysis of Response of a High-Impedance Nuclear Reactor Power Indicator Channel. *R. J. Allen,* Atomics International

Circuits in the MTR Pulse Analyzers. *Frank Petree,* Phillips Petroleum

Halogen Tube Remote Area Monitoring System. *H. A. Brown, J. V. Rogers,* Tracerlab, Inc.

2:15 p.m. Reactor Component Design

Stress Analysis of the Function between a Support Skirt and Pressure Vessel. *R. F. Wojcieszak,* General Electric Co., Schenectady, N. Y.

Mechanical Couplings for Reactor Sodium Coolant Systems. *B. Minushkin,* Nuclear Development Corp. of America

Cold Traps, Freeze Jackets, and Refrigeration System Used in the HRT. *R. C. Robertson,* Oak Ridge National Laboratory

Stresses in Hollow Cylinders Due to Asymmetrical Heat Generation. *H. Kaus, G. Sonnemann,* Westinghouse Electric Corp.

Some Aspects of Safeguarding High-Pressure Equipment in Nuclear Technology. *R. H. Scott,* General Electric—Hanford Laboratories

Tuesday, April 7

9:00 a.m. Health Physics

Radiation and Contamination Control at the Hanford Reactors. *S. L. Nelson,* General Electric—Hanford Laboratories.

Alteration of Gamma Cell for Plutonium—Gamma Usage. *H. M. Glen,* Oak Ridge National Laboratory

Bases for Establishing Nuclear Safety Criteria. *Norman Ketzlach,* General Electric—Hanford Laboratories

A History of Occupational Exposures to Uranium Air Contamination in Feed Materials Production Facilities. *A. J. Breslin, W. B. Harris,* AEC—Health and Safety Laboratories

The Validity of Film Badge and Pocket Chamber Records in Evaluating the Radiation Exposure of Personnel. *Hanson Blatz,* associate professor of industrial medicine, New York University.

Contributions to Gonadal Dose by Medical and Dental X rays. *J. S. Laughlin and others,* Sloan-Kettering Memorial Institute

9:00 a.m. Heat Transfer

Thermal Contact Conductance of Unbonded Metal-to-Metal and Metal-to-Ceramic Joints. *R. G. Wheeler,* General Electric—Hanford Laboratories

Determination of Local Heat Transfer Coefficients by a Transient Technique. *B. A. Stanley, J. B. Conway,* General Electric Co., Evendale, Ohio

Surface Temperature Measurement of Internally Heated Plates. *J. A. Robinson* and *J. B. Conway,* General Electric Co., Evendale, Ohio

Heat Transfer to Non-Newtonian Fluids. *E. H. Wissler, R. S. Schechter,* University of Texas

Design Selection Technique Applied to Astro-Heat Exchange. *J. R. Boyd,* Lockheed Aircraft Corp.

9:00 a.m. Reactor Instrumentation

An invited paper by J. Haarer

A Transistorized Power Reactor Safety System. *H. H Hendon*

A Digital Start-up Control for Air-Cooled Nuclear Reactors. *S. N. Lehr,* General Electric Co., Cincinnati, Ohio

Magnetic Automatic Power-Range Control for an Aircraft Nuclear Reactor. *S. F. Hemmenway, J. A. Russell, J. L. Schaff, P. C. Sharr,* General Electric Co, Cincinnati, Ohio

Electrical Control System Components for Starting Aircraft Propulsion Reactors. *R. H. Willsey, P. K. Hiser, M. E. Ward, A. D. Wilcox,* General Electric Co., Cincinnati, Ohio

2:15 p.m. Chemistry and Chemical Processing

Development Studies on the Solidification of Radioactive Waste by Fluid Bed Calcination. *J. W. Loeding, E. L. Carls, A. A. Jonke,* Argonne National Laboratory

Radiochemical Reprocessing Costs in an Expanding Nuclear Economy. *C. E. Guthrie,* Oak Ridge National Laboratory

Review of Developments in Reprocessing of Irradiated Nuclear Fuels by Pyrometallurgical Methods. *L. F. Coleman, J. H. Schraidt, G. I. Bernstein,* Argonne National Labortory

Recent Developments in Feed Preparations and Solvent Extraction. *R. R. Bruce, R. E. Blanko, J. C. Bresee,* Oak Ridge National Laboratory

Production of Pure Uranium Hexafluoride from Ore Concentrates. *W. C. Ruch, D. A. Peterson, E. A. Gaskill, H. G. Tepp,* Allied Chemical & Dye Corp.

Investigation of Chemical Methods for Nuclear Reactor Decontamination. *J. L. Zegger, G. P. Panzer,* Alco Products Inc.

2:15 p.m. Power Reactor Design

The Design of Daniels—Boyd Nuclear Steam Generator for a 400-Mw (Net E) Power Plant. *W. Boyd, J. A. Paget, P. Hamel,* Engineering Institute of Canada

Evolution of the Army Package Power Reactor Family. *J. G. Gallagher,* Alco Products Inc.

Design of a 10-Mw$_e$ Sodium Deuterium Reactor Power Plant. *E. D. Oppenheimer, J. G. Duffy, C. Graves,* Nuclear Development Corp. of America

The Potential of Heavy Water Reactors Employing an Organic Coolant. *M. J. McNelly,* Canadian General Electric Co. Ltd.

2:15 p.m. Instrumentation

Effects of Reactor Exposure on Boron-Lined and BF_3 Proportional Counters. *W. M. Trenholme,* General Electric Co., Lynn, Mass.

A System Design for Improved Water-Level Control of Steam Generators. *D. P. Waite,* General Electric Co., Lynn, Mass.

A Differential Pressure Instrument for High Temperature Service. *S. A. Hluchan,* Taylor Instrument Co.

Clamp-on Resistance Temperature Detectors for Reactor Use. *R. G. Clark*

Nuclear Power Plants Acceptance Testing. *W. H. Hamilton, G. H. Conley,* Westinghouse Electric Corp.

Wednesday, April 8

9:00 a.m. Nuclear Fuel Processing Plants—Design and Practice

Design vs Performance of Process and Equipment in a Large-Scale Radiochemical Separations Plant. *A. W. Joyce, E. B. Sheldon, L. C. Perry,* E. I. du Pont de Nemours & Co. (Inc.)

Design and Operation Considerations for Off-Gas Systems in Nuclear Processing Plants. *L. R. Michels,* General Electric—Hanford Laboratories

An Evaluation of the Design and Performance of the Thorex Plant. *G. S. Sadowski, W. R. Winsbro,* Oak Ridge National Laboratory

Comparison of Design and Operating Performance at the Idaho Chemical Processing Plant. *A. L. Ayers, F. M. Warzel,* Phillips Petroleum Co.

9:00 a.m. Radio Tracers in the Process Industries

Measurement of Gear Wear by Activating Wear Particles in the Lubricant. *H. D. Briggs,* General Electric Co., Schenectady, N. Y.

Radioisotope Utilization in Industrial Applications. *P. Kruger,* Nuclear Science & Engineering Corp.

Radiochemical Tracing of Pilot Unit Fluid Catalyst Flow. *A. von Rosenberg, R. L. Hull,* Humble Oil and Refining Co.

An Investigation of Sodium Phosphate Hideout in Boiling Water Using Phosphorus-32. *J. W. Stout, Jr.,* Baltimore Gas and Electric Co.

A Radio Tracer Study of Flow Patterns in a Fluid Coker. *J. M. Ausman, A. Beerbower, R. E. Olsen,* Esso Research and Engineering Co.

9:00 a.m. Reactor Physics

Nuclear Analysis of Small Thermal Reflected Cylindrical Homogeneous Critical Assemblies. *G. P. Rutledge, P. A. Kantorczyk, M. R. Stuart,* Westinghouse Electric Corp.

Nuclear Calculation for a Continuously Fueled Pebble-Bed Reactor. *R. O. Bagley,* Alco Products Inc.

AEC Reactor Physics Program. *W. C. Bartels,* Atomics Energy Commission

Sodium Graphite Reactor Stability Analysis. *J. Reichman,* Atomics International

Neutron Energy Spectrum Calculations in Reactor Shields. *J. W. Haffner,* General Electric Co., Evendale, Ohio

2:15 p.m. Fuel Technology

Fabrication of BR-2 Fuel Elements. *A. Strasser,* Nuclear Development Corp. of America

Nondestructive Clad Thickness Measurement of Uranium Oxide Fuel Pins. *R. M. Ball,* Babcock & Wilcox Co.

The Fabrication of Tubular Fuel Elements. *S. Megeff, J. L. Zambrow,* Sylvania–Corning Nuclear Corp.

UO_2 Ceramic Fuel. *R. M. Powers,* Sylvania-Corning Nuclear Corp.

Rate of Alloying of SRE Metal Fuels with Stainless Steel Above 1,500 F. *R. S. Neymark,* Atomics International

Irradiation of Fuel Elements Containing UO_2 Powder. *J. L. Bates,* General Electric—Hanford Laboratories

2:15 p.m. Isotope Application

Controlling Thickness of Plastic Film Using Beta Ray Gauges. *G. C. Wiggins,* Dow Chemical Co.

Control of Fat Centrifuge by Gamma-Ray Measurement. *F. Brown,* George A. Hormel & Co.

Process Applications of Radio Isotopes in a Chemical Company. *R. A. Mulcahy, C. B. Moore,* E. I. du Pont de Nemours & Co. (Inc)

Operating Experience with Instruments Using Radio Isotopes in the Process Industries. *R. C. Kimball,* American Viscose Corp.

Measurement of Liquid Density Using a Beta-Ray Source. *E. J. Freh, Charles Kearns,* Industrial Nucleonics Corp.

Continuous Analysis by X-ray Absorption. *A. Beerbower,* Esso Research & Engineering Co.

2:15 p.m. European Power Reactor—A.

The Hunterston Project and the Future Development of the Gas-Cooled Power Reactor. *K. J. Wootton,* Kent, England

The Berkeley Power Station and Its Influence on Future Developments. *A. L. Shaw,* AHWC, AMIEE

Multipurpose Reactor for Spain. *R. K. Winkleblack,* Atomics International

The Status of Nuclear Power in Italy. *Prof. Felice Ippolito,* Rome, Italy

Thursday, April 9

9:00 a.m. European Power Reactor—B.

Marcoule's Reactors G.2 and G.3—Some Features

Part I. Core, Shielding, and Pressure Vessels. Societe des Forges et Ateliers du Creusot, Compagnie Industrielle des Travaus, and Coyne et Bellier

Part II. On Load Refueling. Societe Alsacienne de Constructions Mecaniques

Part III. Reactor Cooling—Gas and Vapor Circuits. Societe Rateau and Chantiers de l'Atlantique

Part IV. Station Control. Alsthom

9:00 a.m. Fusion Processes

The Present Status of Thermonuclear. *Dr. A. E. Ruark*

Problems of Fusion. *J. L. Tuck*

A Survey of Fusion Processes. *R. F. Post*

The Design and Operation of a Shunt Regulated 25,000 Joule Inductive Energy Storage System. *R. L. Gamblin,* James Forrestal Research Center

9:00 a.m. Metallurgy and Materials—I

The Fabrication of Tubular Uranium Fuel Elements. *C. E. Polson, H. Davis, J. F. MacNeill, J. F. Schiltz, J. Magoun,* National Lead Co.

Fabrication of Urania Dispersed in Graphite Fuel Elements. *J. H. Handwerk, F. D. McCuaig, C. H. Bean,* Argonne National Laboratory

Tensile Creep of Pure and Uranium-Loaded Graphites. *L. Green, Jr., M. L. Stehsel, C. E. Waller,* Aerojet-General Corp.

The Use of Isostatic Pressure Techniques in the Fabrication of Fuel Elements. *J. Fugardi, J. L. Zambrow,* Sylvania–Corning Nuclear Corp.

Segregation in Aluminum-13% Uranium Castings. *D. Peckner,* Westinghouse Electric Corp.

The Swelling of Irradiated U-Zr Alloy During Temperature Transients. *W. V. Johnston,* Knolls Atomic Power Laboratory

The Effect of Metallic Impurities on the Properties of Uranium and 2 w/o Molybdenum-Uranium Alloys. *J. M. Dickinson E. E. Zukas,* Los Alamos Scientific laboratory

2:15 p.m. Metallurgy and Materials—II

Sinterability of UO Powders for Fuel Elements. *R. B. Wrinkle,* Mallinckrodt Chemical Works

Mechanism of Sintering of Ceramic Materials. *R. Chang,* Atomics International

Forge Rolling Zircaloy Components. *R. D. Johnson,* Clevite Research Center

Irradiation-Induced Hydrogen Absorption by Nickel-Enriched Zircaloy-2. *W. Yeniscavich, R. A. Wolfe, R. M. Lieberman,* Westinghouse Electric Corp.

The Use of Ultrasonics in the Testing of Irradiated Fuel Elements. *J. M. Fouts,* General Electric—Hanford Laboratories

The Development of Nuclear Radiation Resistant Fluids and Lubricants. *W. L. R. Rice, Lt. D. A. Kirk,* Wright Air Development Center

Sodium Corrosion as a Function of Time. *J. M. McKee,* Nuclear Development Corp. of America

Purification of Lithium by Vacuum Distillation. *W. Arbiter, S. Lazerus,* Nuclear Development Corp. of America

2:15 p.m. Reactor Operating Experience and Maintenance

Extended Zero Power Experiments on the APPR-1 Core. *S. David Mackay,* Alco Products Inc.

Operational Problems of the Original Hanford Reactors. *J. R. Young,* General Electric—Hanford Laboratories

The Buildup of Radioactivity in the Primary System of the Army Package Power Reactor. *W. S. Brown,* Alco Products Inc.

Detection of Sodium Leaks in the SDR. *H. Steinmetz, R. Winkelstein,* Nuclear Development Corp. of America

Inspection and Maintenance Experience with HRE II. *D. M. Shepherd, C. W. Collins,* Oak Ridge National Laboratory

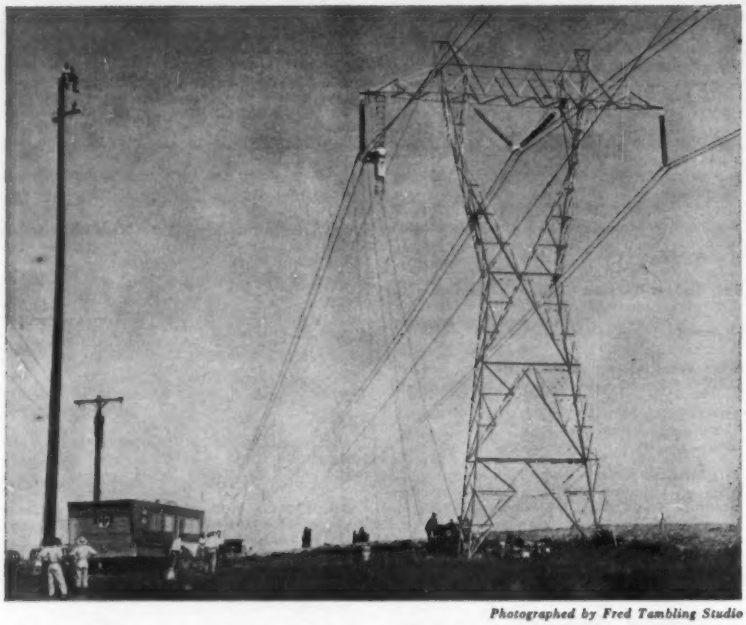
OMRE Operating Experience. *N. J. Swanson, D. R. Muller,* Atomics International

2:15 p.m. European Power Reactor—C

Four or five papers on Soviet Power Plant Technology

Middle Eastern District Meeting

GENERAL COMMITTEE for AIEE District No. 2 Meeting in Baltimore, Md., May 19-21, 1959, includes (seated, left to right): P. P. Ives, secretary; Dr. P. L. Betz, chairman; Mrs. P. L. Betz, ladies' activities; George Cardin, Baltimore Section chairman; T. W. Trice, general session; (standing): T. H. Marshall, arrangements; R. C. Desor, inspection trips; L. J. Huettel, entertainment; J. I. Elliott, publicity; C. B. Bechtel, registration; H. A. Frey, technical meetings and papers. Those not present: W. B. Mann, finance; L. J. Frisco, student activities.



Photographed by Fred Tambling Studio

AN INSPECTION TRIP to Ohio Edison Company's 345-kv test line will be one of the features of the AIEE East Central District Meeting to be held in Akron, Ohio, in conjunction with the 11th annual Rubber and Plastics Conference, April 22-24, 1959.

Theme of District Meeting Will Be "Electricity—Major Tool of Industry"

THE EAST CENTRAL District Meeting will be held in Akron, Ohio, in conjunction with the 11th Annual Rubber and Plastics Technical Conference. This 75th Anniversary meeting will take place April 22-24, 1959, at the Sheraton Hotel.

Several inspection trips planned will include the rubber companies, Ohio Edison's 345-kv test line, Columbia-Southern Chemical Corp., and Chrysler Corp. A tour of Stan Hywet, a high-voltage show at Ohio Brass high-voltage lab, and a banquet and talk on space travel will highlight a full social program for both the ladies and men.

The theme of the District meeting is "Electricity—Major Tool of Industry." The Rubber and Plastics Conference will feature papers on electrical applications in the rubber and plastics industries including calender drives and induction heated extruders. C. H. Linder, vice-president of General Electric Company, will deliver the keynote address.

A 1½ hour high-voltage demonstration at Ohio Brass Company will be held on Wednesday evening so both the men and ladies can attend.

Rubber company tours will include a plant tour of Goodyear Tire & Rubber Company, a trip through the Research Labs of Firestone Tire & Rubber Company to see a historical display of rubber machinery, and a visit to the B. F. Goodrich Company Research Lab.

There will be 10 sessions of technical papers in the District meeting. Briefly, these will cover the following: industrial heating—induction and dielectric; electrical drive equipment—high temperature motors, torque motors, cement and coal drives; static components—silicone rectifiers, rectifiers, thermoelectric; automation; industrial lighting; computers—automatic programming, analog solution, milling machine; high-voltage transmission—tubular steel structures 345-kv tests; relaying and distribution; communication; and high-voltage cables.

Technical sessions for the Rubber and Plastics Conference will include: nylon tire cord processing session—nylon cord properties and drives; calendering session—calender and wind-up drives; static component sessions—transistors and magnetic amplifiers; plastic extrusion session; trends in new machines and processes. In addition to the papers, there will be reports from two working groups, "Problems Due to Atmospheric Contamination" and "Standards for Rubber and Plastics Industries."

The social program will begin with an early arrival reception. A hospitality room will be available to the ladies. They will have a luncheon and style show at the M. O'Neil Company on Wednesday.

On Thursday, the ladies will tour Stan Hywet, the fabulous estate of the late F. A. Seiberling. Mr. Seiberling was founder of two great rubber companies, Goodyear and Seiberling. After his death, Stan Hywet was donated as a cultural and educational center for the Akron area. It is one of the finest examples of English Tudor Revival architecture and contains many art treasures.

The banquet will feature Darrel Romick, nationally known space expert from Goodyear Aircraft Corporation, speaking on recent advances in space travel.

Officers Announced for National Electronics Conference

V. H. Disney (M '50), director of electrical engineering research at Armour Research Foundation, has been elected president of the National Electronics Conference (NEC) for 1959.

Other officers named for the next NEC—to be held October 12-14 at the Hotel Sherman in Chicago, Ill.—are: executive vice-president: L. W. Von Tersch, Michigan State University; secretary: G. E. Anner, University of Illinois; treasurer: G. J. Argall, DeVry Technical Institute; and assistant treasurer: H. E. Ellithorn, University of Notre Dame.

Mr. Disney, a long-time participant in NEC committee work and holder of many offices, is a representative of Illinois Institute of Technology in NEC functions. He is a member of the Institute of Radio Engineers, the Engineers Club, Tau Beta Pi, and Etta Kappa Nu. A native of Moberly, Mo., he now resides in Elmhurst, Ill.

The newly elected NEC chairman of the board is Alfred Crossley, President of Crossley Associates, Inc. Executive secretary elected for 1959 is J. J. Gershon, DeVry Technical Institute.

Committee chairman elected are: arrangements: J. H. Kogen, GPE Controls, Inc.; awards: Gunnar Hok, University of Michigan; exhibits: R. E. Bard, General Radio Company; fellowship award: J. S. Johnson, Wayne State University; finance policy: J. D. Ryder, Michigan State University; housing: W. H. Hayt, Jr., Purdue University; international activities: C. E. Barthel, Jr., Armour Research Foundation; NEC party: W. R. Brock, WBBM Television station; procedures: B. G. Griffith, Teletype Corporation; program: M. E. Van Valkenburg, University of Illinois; registration: Juergen Roedel, Crane Company, and student activities: R. J. Parent, University of Wisconsin.

Two attorneys have been named to serve as general counselors for the Conference. They are Granger Cook, Jr., with the patent law firm of Mason, Kolehmainen, Rathburn & Wyss, and R. E. Petherbridge, patent department director of Ekco Products Company, Chicago.

Over 10,000 registrants are expected at the 15th annual meeting of NEC in Chicago in 1959. Known as the nation's leading forum of electronic research, development and application, it is sponsored by: AIEE, Illinois Institute of Technology, Institute of Radio Engineers, and Illinois and Northwestern Universities. Participants are: Michigan, Michigan State, Notre Dame, Purdue, Wayne State, and Wisconsin Universities, Electronic Industries Association, and the Society of Motion Picture and Television Engineers.

American Power Conference

March 31–April 2, Chicago, Ill.

NEARLY 90 papers will be presented at 27 technical sessions scheduled for the 21st annual American Power Conference to be held at the Hotel Sherman, Chicago, Ill., March 31 through April 2, 1959. Conference Director is R. A. Budenholzer, professor of mechanical engineering at Illinois Institute of Technology, which is sponsoring the Conference.

Three luncheons, and an All Engineers dinner on April 1, will be included in the 3-day program.

The Conference is conducted with the co-operation of a group of educational institutions and technical societies.

The colleges and universities are Illinois, Iowa, Iowa State, Michigan, Michigan State, Northwestern, Purdue, Minnesota, Wisconsin, Texas A&M, New York, California Institute of Technology, Georgia Institute of Technology, and Massachusetts Institute of Technology.

The societies are AIEE, American Institute of Chemical Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Civil Engineers, American Society of Heating and Air Conditioning Engineers, American Society of Mechanical Engineers, National Association of Power Engineers, Western Society of Engineers, and Engineers' Society of Milwaukee.

Tuesday, March 31

9:00 a.m. Registration—Mezzanine Floor, Sherman Hotel

10:00 a.m. Opening Meeting—Grand Ballroom

Chairman: Dudley Sanford, Union Electric Company

Co-Chairman: W. A. Lewis, Illinois Institute of Technology

Invocation: The Rev. W. D. Faughnam, chaplain, Illinois Institute of Technology

"Education for Management in a Technological World." W. F. Rockwell, Jr., president, Rockwell Manufacturing Company

"Integration of Engineering and Financial Planning of Electric Power Systems." Murray Joslin, vice-president, Commonwealth Edison Company

12:15 p.m. Joint APC-ASME Luncheon—Bernard Shaw Room, sponsored by American Society of Mechanical Engineers

Chairman: G. B. Warren, president, ASME

Co-Chairran: M. V. Maxwell, chairman, Chicago Section, ASME.

Speaker: J. E. Corette, president, Edison Electric Institute, president and general manager, The Montana Power Company

2:00 p.m. Steam Turbines—Grand Ballroom, Sponsored by Power Division of ASME

2:00 p.m. Extrahigh-Voltage Systems—Louis XVI Room

Chairman: E T. B. Gross, Illinois Institute of Technology

Co-Chairman: H. A. Frey, General Electric Company

The Extrahigh-Voltage Systems in USSR. *B. P. Lebedev,* USSR Ministry of Power Stations, Moscow, USSR

The 300-Kv System. *H. W. Haberl,* Quebec Hydro Electric Commission

The 345-Kv System. *E. A. Rothfus,* Ohio Edison Company

CP59-495 Extrahigh-Voltage Cable—Challenge of the Future. *C. S. Schifreen,* Philadelphia Electric Company

2:00 p.m. Water Technology I. Ion Exchange—Assembly Room

2:00 p.m. Fuels—Crystal Room, sponsored by Fuels Division of ASME

8:00 p.m. Evening General Interest Session—Assembly Room

"Long-Range Goals for the Generation of Electric Power"

Devoted to present thinking and future prospects for direct conversion of heat into electric energy and for achieving electric power from fusion. Following presentation of papers, discussion and questions from the audience will be welcome.

Chairman: A. W. Kramer, editor of *Atomics, Power Engineering*

Co-Chairman: P. L. Blackshear, Jr., University of Minnesota

Direct Conversion of Heat to Electric Power—Its Present Status and Future Prospects. *J. C. R. Kelly, Jr.,* Westinghouse Research Laboratory

Thermonuclear Fusion Research for Power. *L. J. Linde,* C. Stellarator Associates of Allis-Chalmers and Radio Corporation of America

Wednesday, April 1

9:00 a.m. Symposium on Once Through Boiler Plants for Subcritical Pressure—Grand Ballroom

9:00 a.m. Hydroelectric Power I. The Nation's Hydro Resources, Review of Policies—Crystal Room

Chairman: A. J. Ackerman, Hydroelectric Planners

Co-Chairman. A. T. Lenz, University of Wisconsin

The Federal Power Commission—Licensing Procedures and Regulations under the Federal Power Commission, Washington, D. C.

Example of Hydroelectric Development by a Private Utility. *H. N. Henry,* Alabama Power Company

Policies in Cost Estimating, Earnings Analysis, and Financing. *P. P. Stathas,* Duff and Phelps, Inc.

9:00 a.m. Electrical Industrial Session—Louis XVI Room, sponsored by Industrial Group, Chicago Section, AIEE

Chairman: I. Rosenak, Inland Steel Company, Indiana Harbor Works

Co-Chairman: G. G. Thorpe, chairman, Industrial Group, Chicago Section, AIEE

"Symposium on Training of Personnel in Maintenance of Complex Electrical Controls"

Panel Members:
Norman Cutliff, International Harvester Company
M. A. Jacobs, A-C Spark Plug Division, General Motors Corporation
A. Swatek, Inland Steel Company, Indiana Harbor Works

9:00 a.m. Water Technology II. Analytical and Control—Assembly Room

10:30 a.m. High-Voltage Transmission—Louis XVI Room

Chairman: A. D. Caskey, Commonwealth Edison Company

Co-Chairman: J. W. Nilsson, Iowa State College

Experience with High-Voltage Twin Conductor Lines. *N. H. Erlandson* Carolina Power and Light Company

CP59-496. A 34.5-Kv Polyethylene Insulated Cable Installation. *G. J. Crowdes,* Simplex Wire & Cable Company

10:30 a.m. Water Technology III. Condenser Tubing Alloys—Assembly Room

12:15 p.m. APC-AIEE Luncheon—Bernard Shaw Room, sponsored by the AIEE

Chairman: R. B. Gear, vice-president, District No. 5, AIEE

Co-Chairman: J. A. Romano, Chairman, Chicago Section AIEE

Speaker: E. L. Butz, dean of agriculture, Purdue University

Subject: Research—Gateway to the Future

2:00 p.m. Central Station Power Plants—Grand Ballroom

2:00 p.m. Hydroelectric Power II. The Nation's Hydro Resources, Current Developments and Future Potentialities—Crystal Room

Chairman: R. T. Colburn, Chas. T. Main, Inc., Consulting Engineers,

Co-Chairman: N. W. Newmark, University of Illinois

Soviet Science

PERGAMON INSTITUTE announces the publication of a *News Bulletin* listing translated titles of articles published in recent issues of the Soviet journal "Elektrichestvo" (Electric Technology). This Bulletin is available free of charge to members of the AIEE. Members wishing to take advantage of this offer should write to: ELT Bulletin, Pergamon Institute, 122 E. 55th St. New York 22, N. Y.

Hydro Potentialities as Indicated by the Federal Power Commission. *F. L. Weaver,* Division of River Basins, Federal Power Commission

Hydroelectric Projects and Future Program of the Corps of Engineers. *Brigadier General J. L. Person,* Assistant Chief of Engineers for Civil Works

Developments and Sale of Hydroelectric Power by the Bureau of Reclamation. *W. A. Dexheimer,* Bureau of Reclamation

Discussions: Hydro Potentialities.

Northwestern States. *E. R. de Luccia,* Pacific Power and Light Company

Southwestern States. *W. R. Johnson,* Pacific Gas and Electric Company

Northcentral States. *J. D. Howard,* Wisconsin Power and Light Company

Southcentral States.

Northeastern States. *B. O. McCoy,* Vermont Electric Power Company, Inc.

Southeastern States.

2:00 p.m. Control of Generation on Interconnected Systems—Louis XVI Room

Chairman: Nathan Cohn, Leeds & Northrup Company

Co-Chairman: J. J. Carey, University of Michigan

Operating Experience with an Automatic Dispatching System. *H. H. Mochom,* Connecticut Valley Power Exchange

Co-ordination of a Desired Generation Computer with Area-Wide Generation Control. *N. E. Brown, Harry Fereshetian, M. D. Liechty,* Leeds & Northrup Company

Operating Experience with a Command-Type Load Frequency Control System. *W. D. Wilder,* Niagara Mohawk Power Corporation

2:00 p.m. Water Technology IV—Assembly Room

3:30 p.m. Water Technology V. Industrial Water—Assembly Room

6:30 p.m. All Engineers Dinner—Grand Ballroom

Presiding: Philip Sporn, president, American Electric Power Company

Speaker: H. D. Vogel, chairman of the board, Tennessee Valley Authority

Subject: "Engineers Must Do Better"

Thursday, April 2

9:00 a.m. Steam Generators—Grand Ballroom, sponsored by the Power Division of ASME

9:00 a.m. Industrial Plants I—Assembly Room

9:00 a.m. Peaking Service—Louis XVI Room

Chairman: T. E. Cuhman, Union Electric Company

Co-Chairman: Severin Raynor, Northwestern University

Automatic Plants for Peaking. *E. W. Kettering, B. B. Brownell, B. H. Hefner,* Electromotive Division, General Motors Corporation

Design Concepts of a Low-Cost Gas Turbine Generating Plant for Peak-Load Service. *A. O. White, R. J. Carpenter,* General Electric Company

9:00 a.m. Protection—Crystal Room

Chairman: E. R. Moore, The Detroit Edison Company

Co-Chairman: E. L. Nicolson, General Electric Company

CP59-499 Lightning Protection for Electrical Equipment—Development and Present Status. *H. R. Armstrong,* chairman, AIEE Protective Devices Committee

Shielding Practices for Medium-Voltage Cables. *J. E. Maher,* General Electric Company

9:00 a.m. Circuit Breakers without Oil—Crystal Room

Chairman: Otto Naef, American Electric Power Service Corporation

Co-Chairman: Paul Cartwright, University of Minnesota

CP59-500 High-Voltage, High-Capacity Air-blast Circuit Breakers. *W. B. Wilson, R. B. Shores,* General Electric Company

Gas-Filled High-Voltage, High-Capacity Circuit Breaker. *R. E. Friedrich,* Westinghouse Electric Corporation

High-Voltage Vacuum Power Circuit Breakers. *J. W. Rittenhouse,* Hi-Voltage Equipment Co.

A 15-Kv Vacuum Switch. *H. B. Balfour,* Louisiana Power & Light Co.; *G. N. Lester, H. M. Pflanz,* Allis-Chalmers Manufacturing Co.

10:30 a.m. Nuclear Power Plants I—Louis XVI Room

Chairman: R. M. Casper, Allis-Chalmers Manufacturing Company

Co-Chairman: A. H. Stenning, Massachusetts Institute of Technology

Power Reactor Safeguards. *R. H. Shannon,* United Engineers and Constructors, Inc.

A Design Code for Power Reactors. *D. B. Singer,* Armour Research Foundation

12:15 p.m. APC–WSE Luncheon—Bernard Shaw Room, sponsored by the Western Society of Engineers

Chairman: W. R. Marston, president, WSE

Co-Chairman: A. A. Fejer, Illinois Institute of Technology

2:00 p.m. Nuclear Power Plants II—Grand Ballroom

Chairman: B. I. Spinrad, Argonne National Laboratory

Pebble-Bed Reactor. *S. T. Robinson, R. F. Benenati,* Sanderson and Porter

Industrial Development of Boiling-Water Reactors for the Generation of Competitive Nuclear Power. *R. B. Richards,* General Electric Company

A 150-Mw Organic Moderated Reactor Power Plant. *Ralph Balent,* Atomics International

2:00 p.m. Industrial Plants II—Assembly Room, sponsored by the National Association of Power Engineers

2:00 p.m. Feedwater Circuit—Crystal Room

2:00 p.m. Computers and Network Analyzers—Gold Room

Chairman: L. M. Haupt, Agricultural and Mechanical College of Texas

Co-Chairman: E. B. Eggers, Illinois Institute of Technology

Computers as Aids to Power System Analysis. *Charles Concordia, F. J. Maginniss,* General Electric Company

CP59-494. Simplified Digital Short-Circuit Solution of Power System Networks for the IBM 650. *M. J. Lantz,* Bonneville Power Administration

Patchboards on Networks Analyzers. *J. I. Ykema,* I-T-E Circuit Breaker Company

New Equipment for Network Analyzer Operation. *L. E. Lingo,* Syracuse University

Recent Improvements on the Network Analyzer. *P. M. Anderson,* Iowa State College

Network Analyzer Installations in Canada and the United States. *E. T. B. Gross,* Illinois Institute of Technology

2:00 p.m. Electric Space Heating—Louis XVI Room

Chairman: O. A. Hill, Jr., Commonwealth Edison Company

Co-Chairman: D. H. Madsen, State University of Iowa

Experiences with Commercial and Industrial Heating with Electricity. *G. G. Freyder,* Commonwealth Edison Company

Residential Electric Heating. *J. H. K. Shannahan,* American Electric Power Service Corporation

3:30 p.m. Electric Distribution—Louis XVI Room, sponsored by Power Group. Chicago Section AIEE

Chairman: E. I. Pollard, chairman, Power Division, AIEE

Co-Chairman: E. F. Koncel, chairman, Power Group, Chicago Section AIEE

Providing Underground Service for Residential Areas with Electric Heating. *H. D. Ely, D. P. Jenkins, H. W. Oerman,* Commonwealth Edison Company

Positive Planning in Distribution. *C. E. Flahie,* The Toledo Edison Company

ECPD Publishes 26th Annual Report

Engineers' Council for Professional Development (ECPD) has published its 26th Annual Report, for the year ending September 30, 1958.

According to ECPD President W. L. Everitt, "The year it reviews will probably be remembered best for missiles, satellites, and the resulting popular concern with strengthening education in science and engineering.

"This has been the concern of ECPD for 26 years. We welcome popular support, both moral and tangible. Money can buy some of the tools and labor with which to do our job better, but mostly it takes the priceless, devoted, volunteer service of hundreds of mature engineers, intelligently concerned for the future of their profession and the young people who enter it every year.

"This report is the story of what these

engineers, working together through ECPD, did in the year ending September 30, 1958. It tells how many thousands of high school students were provided the information and guidance by which to make an informed choice for or against an engineering career; how the standards of engineering education were supported by the work involved in the accrediting of college curricula; how professional concepts were brought to engineering students, and the basis for their motivation was analyzed; how the young engineering graduate was helped to continue his professional development in the early years after college, and finally, what is being done to establish the definition of engineering as a profession for the law and for public recognition."

The 26th Annual Report is available from ECPD, 29 W. 39th St., New York 18, N. Y.; $1 per copy.

The New United Engineering Center
A Year-End Report of Progress and Problems

THIS IS A SUMMARY of progress and problems. By the time it is published, there will doubtless be more progress and new, if not fewer, problems. Right now, at the close of 1958, there is a healthy balance of progress and problems: the kind of balance that always stimulates and challenges engineers.

Progress

In a little over a year, the United Engineering Trustees and their Real Estate Committee have secured what the experts call the best site in New York, on the west side of United Nations Plaza between East 47th and East 48th Streets. This site was assembled after negotiating purchases of a variety of small properties from six different, and some difficult, owners. The last of the tenants have moved, demolition of the buildings is complete, and the site was cleared early in January. The general contractor should be selected in February. Shortly after the funds are in hand, ground breaking could take place; and, if all goes well, the building can be completed by early 1961. The "if-all-goes-well" is a part of the problem to be discussed shortly.

The architects, Shreve, Lamb, and Harmon Associates, have completed preliminary plans and called for bids on the general contract. Only a courageous architect would undertake a building for a group of engineers. In this case, courage is re-enforced by experience. This firm has for many years been consulting architects to United Engineering Trustees on alterations, and plans for renovation and replacement of the present building on 39th Street. Many details are yet to be settled, but the basic plan is agreed upon. There will be a 20-story tower with penthouses rising from a 2-story basic structure over a basement. The gross floor area will be 280,000 square feet. The tower will be approximately 65 by 140 feet. The basement, and two large floors housing the library, cafeteria, and central services will occupy the United Nations Plaza block front to a depth of 225 feet on 48th Street and 150 feet on 47th Street. Present plans call for a 13-story wing to provide for expansion when needed about 15 years from now.

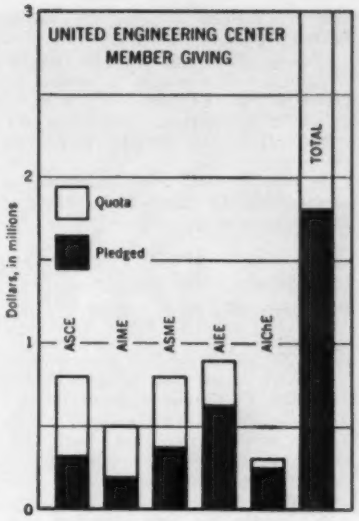
Problems

It isn't right to put the matter of finances entirely under the head of "problems." More than half of this story belongs under "progress." Of the $8 millions needed, $5.5 millions have been given in cash or pledged by the end of December 1958. Some 284 industry gifts totaling $3.85 millions have been received; 32,000 members have given $1.65 millions. Of the Founders Society members, 17.7% have given 55% of the member-gifts quota. More than 40 local Sections of the Founder Societies have met and exceeded their quotas. That's progress.

The only real problem is how to put clearly before every member of the Founder Societies the importance and urgency of this project. Every local Section that has made a personal appeal to every member has exceeded its quota. There is every reason to be sure that the job can be done as it should be; on a man-to-man basis where the member lives and works.

The consequences of failure are unthinkable. Over 50 years ago, the original three "Founder Societies," numbering 16,000, less than a tenth of the total membership of the present five, 180,000, raised by member subscriptions over a half million dollars (1907 dollars, that is) to buy the ground and help build the present headquarters on 39th Street. The gift of Andrew Carnegie, $1,050,000, then was of a relative size comparable with what industry is undertaking to do now, considering inflation, increased building costs, and wealth of the industry today. It is hard to believe that these 50 years have brought a regression in professional consciousness and pride that would permit a failure in this campaign. We can't settle for less of a building; we can't afford a mortgage; we can't continue to serve our growing membership in our present location.

Engineering, as an organized profession, is facing a test. There is much talk of "unity"; there is said to be need for a "survey"; there is talk of "testing the grass roots." This campaign for a very modest sum of money will serve very well for all of these purposes. If we can't successfully take this small step toward a simple, tangible goal in unison, we have our answer. That's all the survey we need. Truly, the consequences of failure are unthinkable. So, let's not think any more about them, and get on with the job. We are a little behind schedule, that's all.



THE BAR GRAPH shows the status of member giving as of January 16, 1959. All contributions to the UET Building Fund are tax deductible.

What do we do when we get behind schedule? We put in some overtime. Member campaign solicitors, take a couple of evenings, if you can't make it in the daytime, and call on your prospects. Members, if you haven't been solicited, call up your Section Chairman or Secretary and tell him you're ready—ready to make your own pledge, and ready to lend a hand in cleaning up the campaign in your Section.

A member of one of our Founder Societies read the campaign brochure and remarked that amounts tabulated at the end as illustrations of tax credits available on various sizes of gifts was apparently to be taken as a guide for giving to this campaign. He felt the inferred amounts were away out of line; too high. "Why," he said, "that's the kind of contribution one might make to a church building fund or to all his local charities in one year." Well, yes, maybe it would work out something like that. But then some of us feel that our profession should be housed in a worthy structure too. Like the church building fund, this is a once-in-a-lifetime, and it's tax deductible too.

Notes on the Building Fund Campaign

Machine Accounting. With nearly 24,000 subscriptions on November 28 and the prospect of at least 60,000 subscriptions when the $5 million goal (of the Member Gifts Campaign) is reached, the clerical load loomed large. So, on December 15, 1958, the major part of the accounting

load was turned over to the Service Bureau Corporation of IBM.

Industry Giving Results. The Industry Campaign, with a goal of $5 million, reported a total on January 9, 1959, of $3,742,108. In addition, $169,200 has been subscribed in the Greater New York Campaign.

On January 9, the total subscriptions in all campaigns was $5,672,073, or 70.9% of the total goal of $8 million.

E. R. Needles Re-elected President of EJC for 1959

E. R. Needles, prominent consultant in civil engineering, has been re-elected president of Engineers Joint Council (EJC) for 1959, by EJC's board of directors. At the same time, Dr. A. B. Kinzel, vice-president for research, Union Carbide Corporation, was elected vice-president of EJC.

Mr. Needles has been identified with the financing, design, and construction of major expressways, including the Maine, New Jersey, and West Virginia turnpikes, and is a bridge builder of note. A native of Missouri and a graduate of the Missouri School of Mines, Mr. Needles is a past president of the American Society of Civil Engineers and of the American Institute of Consulting Engineers and the American Road Builders Association. Long active in engineering society affairs, he has, for the past year, headed EJC, the unity organization of the engineering profession, representing nearly 300,000 graduate engineers.

Dr. Kinzel, a native New Yorker, is one of the country's leading research metallurgists, pioneering in ferro-alloys, atomic energy and, most recently, in heading the research for a new process for making titanium metal. He is a graduate of Columbia University, Massachusetts Institute of Technology, and holds the doctor of science degree from the University of Nancy, France. He has received honorary degrees from New York University and Clarkson College of Technology. He is currently president of the American Institute of Mining, Metallurgical, and Petroleum Engineers and an active committeeman in the American Society for Metals and the American Welding Society. Dr. Kinzel has been with Union Carbide Corporation since 1926.

Other officers of EJC include E. P. Lange, secretary; L. K. Wheelock, assistant secretary; and E. L. Chandler, treasurer.

The membership of EJC includes 20 of the nation's leading engineering societies.

AIEE Section Describes New Student Relations Idea

AIEE Sections which do not have a 4-year college within their boundaries will find the student relations activities of the Northeastern Michigan Section of special interest. The idea is equally applicable to all Sections, but is especially adaptable to those having no college-level engineering students to work with.

Realizing that all college students were at one time high school students, the Northeastern Michigan Section decided to promote interest in engineering and scientific vocations among the high school group. Student Relations Chairman H. V. Crandall is division engineer for Consumers Power Company, Bay City Division. In this capacity, he also heads a group of electrical engineers who, under Consumers sponsorship, act as industry co-ordinators for several JETS (Junior Engineering Technical Society) clubs. Many members of the Section also have similar duties in other divisions of Consumers throughout Michigan. Their enthusiasm for this work naturally carried over into AIEE activities.

Recognizing the advantage of encouraging these young men of the JETS clubs along engineering lines, Section members invited club members to be their guests at selected Section dinner meetings, where they met and listened to experts in many fields of engineering. A surprising amount of interest was thus developed among these high school students. Many were convinced that a career in engineering was what they wanted and are now going on to college to further this desire.

Other Sections may not have a made-to-order source of potential engineers and scientists with which to work, but a little investigation will turn up plenty of eager young minds in their local high schools. Many may just be waiting to join a JETS club, yet not know that such an organization exists. Several clubs have been sponsored by other engineering societies, but there is always room for more clubs.

JETS originated at Michigan State University in 1950 and has enjoyed phenomenal growth in the last few years. There are now more than 400 clubs in the United States and two in foreign countries. Some 90% of the club members go on to college and 60% of these enroll in engineering courses. Sections wishing to investigate sponsorship of a JETS club can obtain full information from J. W. Groomes, JETS Director, Michigan State University, Box 589, East Lansing, Mich.

There are many other worthwhile high school science groups which will be only too happy to have an assist from experienced engineers. Science Fairs are fertile ground for developing interests along engineering lines. This is a national movement also. Interested Sections should contact local science teachers or write directly to National Science Fair Co-ordinator, J. H. Kraus, 1719 "N" Street, N.W., Washington 6, D. C., for information on how to organize a local Science Fair.

Any effort so invested will be returned many fold, both in personal satisfaction to the individual and in prestige and publicity for the National as well as local unit of AIEE. This has been the experience of the engineers of the Northeastern Michigan Section who have worked both with JETS and with local Science Fairs.

PART of a group of more than 100 Northeastern Michigan Section engineers and their guests—local high school student members of the nation-wide JETS club movement, who enjoyed an inspection trip through the Resistance Welder Corporation's new plant at Bay City, Mich. In the background is a section of a 300-foot-long automated assembly line built by Resistance to produce unitized auto bodies for the Chrysler's 1960 line of cars. This was only one of many interesting operations observed by the group. Movies of actual production line welder operations were shown. Refreshments served following the tour rounded out the program. More than 60 students participated in this AIEE sponsored trip. This is a typical example of student relations work in action in a Section area where no 4-year college exists.

Lehigh Valley Section Presents Prize Paper Awards

The monthly meeting of the AIEE Lehigh Valley Section held at Lehigh University, Bethlehem, Pa., on December 12, 1958, was well attended by regular and student members. First and second

prizes were presented at this meeting to Joseph Teno, professor of electrical engineering at Lehigh University and manager of the Bethlehem Division of the Lehigh Valley Section, for two papers he co-authored for the past year's Section competition.

The first prize was presented for the paper written by Prof. Teno and H. W. Fullerton, research engineer, General Electric Company, entitled "A Mathematical Model and Procedure for Arc-Back Calculations for Power Rectifiers."

The second prize was presented for the paper written by Prof. Teno, R. N. Wagner, chief electrical engineer for the Aluminum Company of America and immediate past chairman of the Pittsburgh Section, and C. Titus, manager of research engineering, General Electric Company, entitled "Comparison of Calculated and Measured Arc-Back Currents in Large Power Rectifiers."

A third prize was awarded to E. F. Reis, an electrical engineer with the Pennsylvania Power & Light Company, for his paper, "An Analysis of Lightning Arrester Thermal Capability."

The paper written by Prof. Teno and Mr. Fullerton has also won National First Prize in the Industrial Division of the AIEE. This paper was given at the AIEE Winter General Meeting in New York. N. Y., on February 2, 1959.

The Lehigh Valley Section prizes were awarded to Prof. Teno and Mr. Reis by Harold Tooker, chairman of the Section's Prize Committee.

The main speaker for the meeting was L. W. Morton, a representative of the General Electric Company, who discussed "Direct Current Transmission," including the historical background of the field, the early American contributions, recent progress made by the Swedes and Russians, the present international status, and the American Electrical Industries point of view.

During the meeting, the Lehigh University Student Branch Chairman, Donald Talheim, presented Section Chairman McNair with a $25 check for the United Engineering Center Fund.

AT A RECENT MEETING of the AIEE Lehigh Valley Section, *(left to right)* H. W. Fullerton, Prof. Joseph Teno, and E. F. Reis, were honored as authors of prize papers. Harold Tooker *(right)*, chairman of the Section's Prize Committee, presented the awards.

Recording and Controlling Instrumentation Conference

A Conference on Analog and Digital Instrumentation will be sponsored by the AIEE Recording and Controlling Instrumentation Committee April 20-21, 1959, at the Bellevue-Stratford Hotel in Philadelphia, Pa. Co-operating societies are the American Society of Mechanical Engineers, Institute of Radio Engineers, and Instrument Society of America.

The tentative program for the Conference follows.

Monday, April 20

9:30 a.m. Session I—Engineering Education for Instrumentation

Chairman: L. J. Lunas, Westinghouse Electric Corporation

The Status of Electrical Measurements in a Modern Electrical Engineering Curriculum. *D. T. Canfield,* Purdue University

Electrical Measurement—In the Core Curriculum. *F. R. Kotter,* National Bureau of Standards

Education for Electrical Measurements in Industry. *S. J. Zammataro,* Bell Telephone Laboratories, Inc.

Control Instrumentation in the Engineering Curriculum. *J. R. Ragazzini,* New York University.

Formal Discussion on Engineering Education Papers

P. A. Borden, University of Dayton; Harry Sohon, University of Pennsylvania; E. W. Conlon, Drexel Institute of Technology.

2:00 p.m. Session II—Electronic Analog Recorders

Chairman: A. J. Williams, Jr., Leeds & Northrup Company

A New Concept of Analog Recording. *D. D. Trautner,* Minneapolis Honeywell Regulator Company, Heiland Division

Electronically Balanced Recorders for Varied Applications. *P. B. Robinson,* General Electric Company, Instrument Department

Evolution of an X-Y Recorder. *F. H. Wyeth, G. S. Talbot,* Leeds & Northrup Company

X-Y Plotters for Military Service. *F. L. Martinson,* Electronic Associates, Inc.

Design and Performance Characteristics of a High-Speed Wide Chart Recorder. *J. C. Garrigus,* The Bristol Company

A Power Line Transient Recorder. *G. H. Hoshall,* Minneapolis-Honeywell Regulator Company, Davies Laboratories Division

2:00 p.m. Session III—Computer Control Systems

Chairman: E. A. Weiss, Sun Oil Company

The GE *312* Computer-Controller System. *A. M. Spielberg,* General Electric Company, Computer Section

Optimizing Control: Theory and Practice. *R. I. Van Nice,* Westinghouse Electric Corporation, New Products Engineering Department

A Solid-State Digital Computing System for Electrical Load Monitoring. *R. J. Thomas,* Union Carbide Nuclear Company; *J. O. Gustafson,* Bailey Meter Company; *G. E. Foster,* Lundell & Company

Digital Control Techniques for Process Instrumentation.

5:30 p.m. Social Hour—Bellevue-Stratford Hotel

Tuesday, April 21

9:00 a.m. Session IV—Data Handling Systems for Industrial Processes

Chairman: A. J. Hornfeck, Bailey Meter Co.

A Digital Recording and Computing System. *M. S. Blynn,* Minneapolis-Honeywell Regulator Co., Brown Instruments Division

A General Purpose Computing-Logger for On-Line Process Control Studies. *K. G. Harple, J. Baconnet,* Leeds & Northrup Company

A New Stored Program Information System *G. S. Daniels,* Panellit, Inc.

The Design of an Industrial Digital Data Handling System. *J. V. Werme,* Data Handling Systems Division, Bailey Meter Co.

Design for Continuous Industrial Operation Computer Data Handling and Control. *E. J. Otis,* Daystrom Systems Division, Daystrom, Inc.

9:00 a.m. Session V—Electrical Transducer Systems for Electric Control

Chairman: N. B. Nichols Taylor Instrument Co.

A Magnetic Amplifier EMF Converter. *H. E. Darling,* The Foxboro Company

Development of an Electronic Differential Pressure Transmitter for Flow Monitoring and Control. *D. J. Aldinger,* Taylor Instrument Companies

Electro-Mechanical Transducers for an Electric Control System. *R. Dallimonti, J. O. Johnson,* Minneapolis-Honeywell Regulator Company, Brown Instruments Division

Ionization Detector for Vapors. *L. E. Maley,* Mine Safety Appliance Company

Electromechanical Balance in Temperature and Pressure Measurement. *E. S. Gilchrist, D. A. Bristol,* Manning, Maxwell & Moore, Inc.

2:00 p.m. Session VI—High-Speed Data Handling and Processing

Chairman: D. R. Mangold, General Electric Company

The Beckman Model *210* High-Speed Data System. *K. L. Chien,* Beckman Systems Division

The Combi-System—A Proposal for New Concepts in Digital Data Processing. *Helmut Schwab,* Consolidated Electrodynamics Systems Division

Accuracy Considerations in Analog-to-Digital Converters for Use in High-Speed Systems. *R. E. Wright,* Epsco, Inc.

Transistorized Buffer Core Memory for Use with High-Speed Simultaneous Measurement of Pressure and Temperature. *S. Reiss,* Fischer & Porter Company

Performance vs Cost Factors in High-Speed Data System Specifications. *R. W. Cronshey, S. G. Reque,* General Electric Company, Computer Department

2:00 p. m. Session VII—Electronic Systems for Process Control

Chairman: E. W. James, E. I. du Pont de Nemours & Co. (Inc.)

Application of Solid-State Devices in an Industrial Process Controller. *E. O. Olsen, The* Foxboro Company

Developments in European Controllers. *E. W. Silvertooth,* General Precision Equipment Corporation, Librascope, Inc.

A Digital Valve Actuator. *J. Wapner,* Fischer & Porter Company

Process Control Gas Chromatography. *H. J. Noebels,* Beckman Instruments, Inc.

An Integrated Miniature Electronic Control System. *E. J. Cranch, W. B. Alden,* Leeds & Northrup Company

Radio Astronomy Observations at the University of Michigan

Prof. F. T. Haddock, associate professor in the departments of electrical engineering and astronomy at the University of Michigan and one of the pioneers in the development of radio astronomy, addressed the January meeting of the Michigan Section of the AIEE on "Radio Astronomy Observations at the University of Michigan."

From 1946 to 1956, Prof. Haddock was engaged in research in radio astronomy at the Naval Research Laboratory. At present, he is directing the radio astronomy research project at the University of Michigan. This project is supported by the Office of Naval Research. He is past secretary of the organizing committee for the Symposium on Radio Astronomy in Paris, 1958.

Prof. Haddock reviewed the history of radio astronomy, the "newest branch of the oldest science," which began with the detection of radio waves in the 20-mc range by Karl Jansky of Bell Telephone Laboratories in 1933. This discovery was one of the most important of the first half of this century. Radar jamming was traced to radio interference from the Sun in 1942. After World War II, the English and the Australians in particular continued extensive investigations and discovered many features such as polarization, intensities, and source size. While plotting noise contours in the late 1940's, a fluctuating noise from the constellation Cygus was detected. The Australians developed an antenna that localized the disturbance to less than 8 minutes of arc in diameter. Further studies indicated that this was the result of two galaxies in collision. This was confirmed by photographic and spectral observations at Mount Palomar Observatory. Many radio stars very probably beyond the optical range of Palomar's 200-inch telescope can be detected only by radio observation.

Today, through radio observations, we are learning much about the structure, composition, and shape of our galaxy and know the number of arms between the earth and the center. This could not be done by optical means because of the wheel shape of our galaxy and the large quantities of stellar dust between the earth and the center. We can, by studying the various wave lengths from the moon, probe a few feet below its surface. We can probe behind the clouds surrounding Venus; have studied the area of the Sun's corona; probed at least one billion light years into space and have discovered invisible localized radio outbursts on the surface of Jupiter. Radiation from optical stars is too weak for detection, except from the Sun, so far. Through radio observations, a celestial map of invisible radio stars is being developed.

Prof. Haddock presented slides showing construction of the new 85-foot diameter parabolic steerable antenna at the University of Michigan, of the 250-foot parabolic steerable antenna at Manchester, England, and the 350 foot by 6 foot fixed antenna in the Soviet Union. His observatory now tracks the sun continuously and scans frequency 3 times per second in the 100- to 600-mc range with a 28-inch parabolic antenna. The speaker showed a dynamic spectral record made in Ann Arbor, Mich., in September 1957.

The new antenna will be one of the finest radio telescopes in the world. It is steerable, has a beam width less than 1/10 of a degree in both planes at the highest operating frequency of 10,000 mc or 3 centimeters. This is the result of precision tracking apparatus and a surface construction which varies no more than 1/8 inch rms from a perfect paraboloid. This unit will have a resolution about 100 times as fine as that at Manchester. Prof. Haddock hopes to be able to "tune in" individual optical stars with this apparatus.

Tom Butler of the University Research Institute was in charge of arrangements for the meeting.

Photographed by Photo-Arts

FELLOW DIPLOMAS AWARDED at December Meeting of the AIEE Philadelphia Section: (*Left to right*) R. W. Wilbraham, retired chief electrical engineer of United Engineers & Constructors, Inc., who presented the certificate to R. R. Wagstaff, chief engineer of United Engineers & Constructors, Inc.; Albert Hansen, Jr., manager, Engineering Subsection of General Electric Company, whose certificate was presented by D. L. Beeman, manager, engineering department of General Electric Company.

Recent Activities of the Philadelphia Section

Some 10 days before the Atlas was launched with man's first experiment in satellite communication, the Philadelphia Section of AIEE at its December meeting heard a talk on "Transoceanic Communication by Means of Space Satellites," by Dr. J. R. Pierce, director of research, electrical communications, at the Bell Telephone Laboratories.

Dr. Pierce described how a number of satellites circulating around the earth could be used either as passive reflectors or as repeater stations for providing broad-band transoceanic communication and channels for multichannel telephony and television. He showed that powered repeaters with solar batteries might be used, or that even passive reflectors such

as large metallized spheres are plausible. He described briefly the position and number of satellites required, the power necessary, the per cent of coverage received, and the frequencies most adaptable.

The speaker has written two technical books, "The Theory and Design of Electron Beams" and "Traveling-Wave Tubes," and a popular technical book, "Electrons, Waves, and Messages." He is a Fellow of the Institute of Radio Engineers (IRE) and of the American Physical Society, and a member of the National Academy of Sciences and of the British Interplanetary Society.

Two recently elected AIEE Fellows were awarded their diplomas with citations. R. R. Wagstaff, chief engineer of United Engineers & Constructors, Inc., was awarded his diploma by R. W. Wilbraham, retired chief electrical engineer of United Engineers & Constructors, Inc., and Albert Hansen, Jr., manager, Engineering Subsection of General Electric Company, was presented his by D. L. Beeman, manager, engineering department of General Electric Company.

The Section recently participated in a Career Forum which had as its purpose, providing career guidance to high school students interested in a scientific or technical career.

A panel of prominent engineers, scientists, and educators were assembled to talk on the subject of "Rockets and Missiles." An expert in the field of aeronautics, electronics, civil, chemical, and mechanical engineering explained what his particular field contributed to the development of the rocket. Following the talks, the students had the opportunity of discussing individual problems with a counselor—about 40 volunteers from local industries and colleges were available.

The forum was held in conjunction with the Franklin Institute and the IRE and was repeated on three days.

Program Announced for Textile Industry Conference

A 2-day Conference on Electrical Application for the Textile Industry will be sponsored by the AIEE Textile Subcommittee, April 2-3, 1959, at the Heart of Atlanta Motel, Atlanta, Ga.

The tentative program for the Conference follows.

Thursday, April 2

9:00 a.m. Registration and Coffee—Auditorium, Heart of Atlanta Motel

10:00 a.m. Morning Session

Presiding: B. R. Stratton, Cutler-Hammer, Inc.

Welcome: R. H. Clark, Warren & Swasey Co. chairman, AIEE Textile Subcommittee

Inspection Lighting for Textile Manufacturing. *Willard Allphin*, Sylvania Lighting Products

Prepared Discussion: J. J. Burns, General Electric Company

AIEE Summer and Pacific General Meeting Seattle, Wash., June 21-26, 1959

THE GENERAL COMMITTEE of the 1959 Summer and Pacific General Meeting hears General Chairman H. R. Loew discuss a knotty problem in the planning for the Seattle meeting next June. Pictured (*left to right*) are: (seated) C. R. Kingsbury, trips; T. J. Martin, properties; Mrs. C. S. Alger, ladies entertainment; C. S. Alger, secretary; H. R. Loew, general chairman; H. R. Brown, vice-chairman; H. V. Strandberg, treasurer; R. E. Kistler, member-at-large; (standing) J. D. Eicher, finance; A. W. Kessler, chairman Seattle Section; R. L. Simmons, sports; R. V. Davis, publicity; D. N. Exner, Aircraft Technical Conference representative; D. E. Edwards, hotels; F. D. Robbins, student activities. Not present were R. L. Lemmon, entertainment; F. R. Bergseth, program; J. V. Lamson, registration; and G. D. Jorgensen, transportation.

Boeing Airplane Company Photo

A VISIT to the Boeing Airplane Company will be among the inspection trips offered during the AIEE Summer and Pacific General Meeting. Shown here in Boeing's flight line in Seattle, Wash., are B-52 Stratofortresses. The giant eight-jet bombers have rolled off Boeing's final assembly line and are being given preflight checks prior to their first flight. Boeing B-52s also are under production at the aircraft firm's Wichita Division in Kansas.

The Disease Called Power Factor and How Capacitors Can Profitably Cure This Disease. *H. J. Forbes, Sr.*, Celanese Corporation

Prepared Discussion: R. W. Wages, Georgia Power Company

12:20 p.m. Lunch and Inspection Tour of Engineering and Architects Building

2:30 p.m. Afternoon Session

Presiding: R. I. Uhl, West Point Manufacturing Company

A Practical Understanding of Semiconductors. *Dr. Gene Strull*, Westinghouse Electric Corporation

Application of Semiconductor Drives in the Textile Industry. *C. D. Beck*, General Electric Company

Friday, April 3

9:00 a.m. Morning Session

Presiding: W. S. Hines, Westinghouse Electric Corporation

Is Your Electrical System Safe. *Guy Booker*, Chemstrand Corp.

Prepared Discussion: Swaffield Cowan, Factory Insurance Association

How To Secure Optimum Performance of Your Commutators and Brushes. *D. R. Dobson*, Stackpole Carbon Co.

Prepared Discussion: National Carbon Co.

How You Can Decrease Down Time on D-C Adjustable Speed Drives by Systematic Trouble Shooting. *C. D. Wright* Reliance Electric Co.

Prepared Discussion: M. E. Stout, E. I. du Pont de Nemours and Co. (Inc.)

Successful Globe Comm-II Held in St. Petersburg, Fla.

Jointly sponsored by the AIEE Communications Division and the IRE (Institute of Radio Engineers) Professional Group on Communications Systems (PGCS), the Second National Symposium on Global Communications (Globe Comm-II), was held December 3-5, 1958, at the Colonial Inn and adjoining Desert Ranch, St. Petersburg, Fla.

The attendance numbered nearly 900 people who came from every State in the Union, including Alaska; also the Philippines, Australia, and several European countries. There were 29 exhibitors, part of them housed in each of the two hotels. Some 69 technical papers were presented.

The host organizations were the Florida West Coast Section IRE, the Tampa Section AIEE, and the Florida West Coast Section IRE-PGCS.

The general chairmen were: E. N. Dingley, Jr., National chairman of the PGCS and senior staff research engineer with Electronic Communications, Inc., representing IRE, and I. L. Garcia, of Florida Power Corporation, representing AIEE.

In addition to the general chairmen, the members of the Steering Committee were: L. G. Cumming, IRE Headquarters, New York; R. S. Gardner, AIEE Headquarters, New York; R. E. Raymond, Florida Power Corp.; E. L. White consultant; P. R. Gibbons, Tampa Electric Co.; and M. R. Donaldson, Electronic Communications, Inc.

Committee Chairmen were: M. R. Donaldson, Electronic Communications, Inc., technical papers; R. E. Lazarchik, Sperry Microwave Electronics Co., exhibits; T. F. Thompson, Jr., Florida Power Corp., registration; Leslie Spencer, Electronic Communications, Inc., publicity; D. E. Knauss, Florida Power Corp., treasurer; Rocco Griesi, Electronic Communications, Inc., local arrangements; Mrs. G. E. Reynolds, Jr., ladies program.

A well-attended formal luncheon was given on December 3 at the Colonial Inn at which Harry Davis, scientific director of the Rome Air Development Center was the speaker. The title of his address was, "A Civil Servant Looks at Research and Development."

There was also a cocktail party on December 3, and a ladies' luncheon on December 4. This was followed by a formal banquet that evening, at which D. G. Fink, president of the IRE, and director of research of the Philco Corporation, Philadelphia, Pa., gave an address entitled, "Global Communications—The Case for Confinement."

At the banquet, Dr. H. H. Beverage (F '48), chief technical advisor, communications, RCA Laboratories (retired), Fellow of the IRE, was presented with the IRE-PGCS Achievement Award for outstanding contributions to science and techniques of communications systems. His award carried a certificate and honorarium of $250. Besides this award, the IRE-PGCS Transactions Contribution Award for the best paper published in the IRE *Transactions* on Communications Systems during 1958 was presented to co-authors R. T. Adams and B. M. Mindes, both of ITT Laboratories, Nutley, N.J., for their paper entitled, "Evaluation of Intermediate Frequency and Base Band Diversity Combining Receivers," as published in the June 1958 issue. This award carried individual certificates for Mr. Adams and Mr. Mindes, as well as an honorarium of $100, which was divided equally. Both of these presentations were made by the Chairman of the PGCS Awards Committee, Dr. Andre Clavier, Fellow of the IRE and vice-president of ITT Laboratories, Nutley, N. J.

The Symposium attracted technical writers from most of the publications in the industry and a gratifying amount of editorial reporting of the highlights of the convention was secured. The local press in the Florida West Coast area, comprising St. Petersburg, Tampa, and Clearwater, gave the convention wide coverage, frequently with front page banner headlines and stories.

Much credit should be given to the co-chairmen and to the various Committees for the efficient manner in which every detail was handled, particularly in view of the large number in attendance.

EJC Executive Secretary Appointed to New Position

F. A. Schultz, assistant secretary of the Unity Mutual Life Insurance Company of Syracuse, N. Y., and international president of the National Office Management Association (NOMA)—a worldwide 18,000-member organization—has announced the appointment by the National Board of Directors of NOMA, of W. T. Cavanaugh as executive director—secretary-treasurer.

Mr. Cavanaugh has been active with the Manpower Commission of the Engineers Joint Council (EJC) as its executive secretary.

Study Group Sponsored by AIEE Pittsburgh Section

The Pittsburgh Section of the Institute recently completed a series of nine meetings for a study group course on Industrial Plant Electric Power Systems. The Section believes that registration was the largest that any of the AIEE Sections sponsoring this study group has had. Attendance averaged 74% of those registered for the full course and the first six sessions had an 85% attendance. The attendance at the last three sessions was reduced because of the Thanksgiving holiday and unfavorable weather experienced during the early part of December.

Study group subjects included: The Industrial Plant Load and the Power Company, Plant Distribution System Planning, Grounding of Industrial Power Systems

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until March 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before March 26.

58-1092 Synchronous Machine Design Using a Digital Computer. *M. Anantha Pai, R. M. Saunders*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

and Telephone Interference, Voltage Regulation and Power Factor, Fault Currents and Protective Devices, System and Equipment Protection, Transformers and Power Equipment, Splicing and Terminating Underground Cable, and Relative Costs of Industrial Distribution Systems.

The Section members wish to express their appreciation for the contributions of the Duquesne Light Company, West Penn Power Company, and Bell Telephone Company toward the success of the study group.

Plans Announced for Empire District Meeting

Plans are under way for the Spring Meeting of the Empire District No. 1 of AIEE. The meeting will be held in Syracuse, N. Y., April 29-May 1, 1959, in the Syracuse Hotel. The theme of the meeting will be "New Horizons in Power and Industry."

A program of wide interest is being prepared and many papers have already been submitted. A tentative outline of the subjects to be covered follows:

Transmission—progress in EHV transmission; effect of EHV on system planning; high-voltage conductors; high-voltage, 345-kv cable testing; d-c transmission; transmission system for the Niagara Project; surge transfer.

Distribution—secondary conductor economics, shunt capacitor banks, rural distribution planning, transformer selection and design, aluminum conductors and stable connections, a-c networks and controls, lightning protection for substations, industrial distribution systems.

Computers—problems of simulation, problems of engineering, economic dispatch computers, system dispatching, industrial controller practices, automation and data processing.

Communications—telephone national dialing system, four parts; supervisory control in missile test center; scanning systems for SAC installations; communications and controls at St. Lawrence seaway.

Nuclear Power—electronic circuits and components.

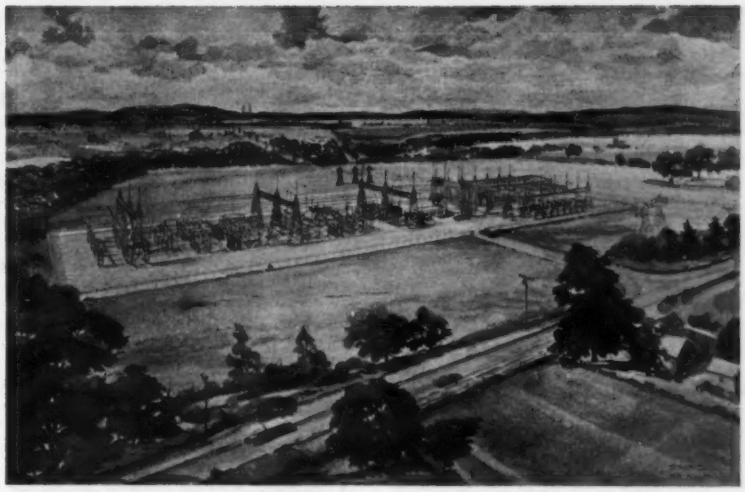
Electronics—electronic circuits and components, tubes and transistors in machine control, CYPAK in industrial applications, mag-amp control for paper machines, constant and adjustable voltage power supplies for d-c shunt motors.

Education for Science and Engineering—panel discussion by prominent educators.

A Student Paper Competition is also planned. The winner of the contest will receive a trip to the AIEE Summer and Pacific General Meeting, all expenses paid.

The plans include a general luncheon, dinner dance, ladies program including some interesting inspection trips, smoker, and inspection trips to some of the industries in the area.

Greater Syracuse has among its industries many outstanding plants such as General Electric Electronics Park and Heavy Military Electronics Division, Brown Lipe Chapin Division of General Motors Corp., Carrier Corp., Bristol Laboratories Inc., Sylvania Electric Products Inc., Halcomb-Sanderson Works, Crucible Steel Co. of America, Pass and Seymour, Crouse Hinds Co., Onondaga Pottery Co., Solvay Process Division, Allied Chemical Co., and many others.



NIAGARA–MOHAWK POWER CORPORATION'S Porter Substation which is the main line connection between St. Lawrence, 230-kv power and the east–west 115-kv transmission lines of Niagara–Mohawk.

AIEE-ASME To Sponsor Railroad Conference in Chicago

A Technical Conference, sponsored by the AIEE Land Transportation Committee and the American Society of Mechanical Engineers (ASME) Railroad Division, will be held at the Hotel Sheraton, Chicago, Ill., April 8-9, 1959.

The tentative program for the Conference follows.

Wednesday, April 8

Chairman: A. V. Dasburg, manager, yard and terminal development, General Railway Signal Company

Vice-Chairman: R. W. Seniff, manager of research, Baltimore & Ohio Railroad Company

Morning Session

TP58-1212. Freight Car Tractive Resistance Measurements by Doppler Radar. *R. D. Campbell*, Union Switch & Signal Company

CP58-1230. A Method for Automatic Control of Car Retarders. *H. C. Kendall, J. H. Auer, Jr.*, General Railway Signal Co.

TP58-1266. An Automatic Speed Control System for a Gravity Freight Classification Yard. *R. J. Berti*, Union Pacific Railroad; *T. J. Dosch*, Reeves Instrument Corp.

12:00 Noon Cocktail and Luncheon—Boulevard Room

Chairman: B. C. Gunnell, chairman, ASME Railroad Division

Marcel Fauriol, commercial attache, Consulate General of France, will present a color film with sound, covering the 200-mph speed tests on the French State Railways.

Afternoon Session

Technical Research on European Railroads. *P. V. Garin*, Southern Pacific Company.

Freight Car Roller Bearing Capacity Effect on Life. *A. D. Edelman*, Hyatt Bearings Division, General Motors Corp.

Machinery for Mechanized Railway Maintenance. *G. M. Magee*, Association of American Railroads

6:00 p.m. Reception—Grand Ballroom Foyer

7:00 p.m. Banquet—Grand Ballroom

Toast Master: G. M. Campbell, vice-president, Baltimore & Ohio Railroad

Speaker: Dr. H. M. Mayer, associate professor of geography, University of Chicago

Topic: The Past and Future Development of Chicago as the Transportation Center of the United States (color slides)

Thursday, April 9

Chairman: C. E. Tack, vice-president and chief mechanical engineer, American Steel Foundries

Vice-Chairman: D. H. Noble, research electrical engineer, Chicago, Rock Island & Pacific Railroad

Morning Session

Corrosion Effects on Railway Equipment. *E. A. Foster*, Association of American Railroads

Characteristics of New Lightweight Commuter Cars. *J. W. Horine*, Pennsylvania Railroad

Tiedowns for Piggyback Operations. *J. A. Gower*, Pennsylvania Railroad

12:00 Noon Cocktail and Luncheon—Boulevard Room

Chairman: P. G. Lessmann, chairman, AIEE Land Transportation Committee

V. E. Gunlock, chairman, Chicago Transit Board, will give an illustrated talk entitled,

'New Horizons for Chicago Metropolitan Area Rapid Transit"

Afternoon Session

CP59-492. Multiple Unit Operation of Diesel and Electric Units on the Milwaukee Road. *L. Wylie,* consulting electrical engineer, Seattle, Wash.

TP59-267. Detector Car History and New Developments. *H. W. Keevil,* Association of American Railroads

CP59-5001. New Wheel Slip-Slide Detection and Correction System. *W. B. Zelina,* General Electric Company

Bell Laboratories and AIEE Announce Mervin J. Kelly Award

Bell Telephone Laboratories and the AIEE have announced the establishment of an award for achievement in the field of telecommunications, to be known as the Mervin J. Kelly Award.

The award is named in honor of Dr. Kelly, formerly president and now chairman of the board of Bell Laboratories,

Dr. M. J. Kelly

who will retire on March 1 after 41 years of scientific and administrative service with the Bell Telephone System. Dr. Kelly is a Fellow of the AIEE and has been active in Institute affairs for 33 years. He is internationally recognized as one of the world's leading scientists and research administrators, whose distinguished achievements have played a large part in the advance of telecommunications during the past four decades.

The Kelly Award will be made annually by the AIEE to an individual who has made an outstanding contribution to the advancement of the art of telecommunications. The prize will consist of a bronze medal, a cash stipend of $1,000, and a certificate. The first award will be made by the AIEE in 1960. The award is being sponsored by Bell Laboratories but will be administered solely by the Institute.

Planning Committee Sets Dates for Conference

Decision to hold the 2nd National Conference on the Application of Electrical Insulation at the Shoreham Hotel, Washington, D.C., December 8-10, 1959, was announced recently by the planning committee. Tentative choice of Chicago, Ill., for 1960 and Montreal, Que., Canada, for 1961 has been reached.

The success of the first Conference, held at Cleveland, Ohio, on September 3-5, 1958, led to the decision to meet annually. Convocation of the Washington Conference has been approved by the AIEE and the National Electrical Manufacturers Association (NEMA), co-sponsors, with other technical societies supporting.

H. H. Chapman, Jr., of Owens-Corning Fiberglas Corporation, New York, N. Y., who was 1958 program chairman, has been selected as general chairman for 1959, to succeed J. R. Perkins, of E. I. Du Pont de Nemours & Co., (Inc.), of Wilmington, Del. M. Nakonechny, of Dow Corning Corp., New York, N. Y., is program chairman; A. E. Bohn, of Electro-Technical Products Division, Sun Chemical Corp., Nutley, N. J., is exhibits chairman; Dr. T. F. Hart, Silicones Division, Union Carbide Corporaton, New York, N. Y., is publicity chairman.

Widespread interest in keeping up with newest developments in electrical insulation was demonstrated by the fact that 1,550 persons registered at Cleveland. Organized as a working conference, 24 sessions were held, at which 135 papers were delivered. More than 60 manufacturers had booths in the exhibit section. The preprint "booklet" containing texts or abstracts of many of the Conference papers, was larger than a metropolitan telephone book.

All exhibits at the Shoreham Hotel will be in the same exhibition hall. Exhibitors can start setting up their booths as early as December 6, and they will have all day December 11 to take them down.

Arrangements have been made for special room rates. Single rooms will start at $10 (compared with standard $14) and double rooms at $15 (instead of $17). The hotel will be at the disposal of the Conference for the entire week, and it is expected that some companies may hold sales meetings or conferences either just before or just after the meeting.

Those attending the meeting of the planning committee which arranged details were Mr. Bohn; E. L. Brancato, U. S. Naval Research Laboratory; G. F. Brown, Silicones Division, Union Carbide Corporation; F. J. Campbell, U. S. Naval Research Laboratory; Mr. Chapman; W. M. Edmunds, Rural Electrification Administration, USDA; Dr. J. W. Kallender, U. S. Naval Research Laboratory; R. V. Lohse, Johns-Manville Corp.; G. E. McIntyre, Dow Corning Corp.; G. L. Moses, Westinghouse Electric Corporation; Mr. Nakonechny; Mr. Perkins; L. R. Samelson, editor and publisher, *Insulation;* H. P. Walker, Bureau of Ships, Department of the Navy.

Monday, December 7, will be reserved for joint meetings by all industry marketing factors. On Tuesday, December 8, it is planned to have prominent figures in national life address the Conference banquet. On Friday, December 11, there will be field trips and pre-arranged tours.

AIEE FELLOWS ELECTED

Board of Directors Meeting, December 11, 1958

Myron Amick Bostwick (AM '42, M '48), protection engineer, Portland General Electric Company, Portland, Oreg., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to relay protection of electric power systems." Mr. Bostwick was born in Spokane, Wash., February 15, 1900. He received his B.S. degree in E.E. from Washington State College in 1926, after which he enrolled in the Westinghouse Electric Corporation Graduate Student Training Course. One year later, he was employed in the relay engineering department of the Westinghouse Meter Division in Newark, N. J., where he continued to work until February 1949. While with Westinghouse, Mr. Bostwick first worked as a development engineer, specializing in the design and manufacture of induction disc overload, directional overload, and differential relays. Later, he was in charge of the development and design of low-voltage network distribution and pilot wire relays. In 1941, he was placed in charge of the relay application group, which aided the sales organization in studying utility protection problems and writing proposals for their solution. This activity included the preparation of instruction books, the design of switchboards, and the application of carrier current equipment for high-speed protective relaying, supervisory control, and telemetering. During this period, Mr. Bostwick obtained 24 patents on protective relays and wrote many AIEE papers on their development and application. In 1949, Mr. Bostwick returned to the West Coast where he is now employed by the Portland General Electric Company as protection engineer. He is an active member of the AIEE Relays Committee (1949-59) and the Pilot Wires Subcommittee, and is chairman of the Pacific Coast Subcommittee. Mr. Bostwick is a registered pro-

Photo-Art Commercial Studios

M. A. Bostwick

W. H. Gille

S. L. Goldsborough

J. V. Lamson

fessional engineer in the State of Oregon. He has taught protective relaying in the graduate schools of Brooklyn Polytechnic Institute and the Oregon State College Extension Service. He is a member of Tau Beta Pi, Sigma Tau, and Phi Kappa Phi. He is an active member of the Portland AIEE Executive Committee.

Willis Howard Gille (AM '31, M '45), chief staff engineer, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the field of electrical control mechanism, particularly for flight control." Mr. Gille was born in St. Paul, Minn., on February 24, 1905. He received the B.S. degree in E.E. from the University of Minnesota in 1929, after which he joined Minneapolis-Honeywell. Among Mr. Gille's contributions to the field is the invention of the aircraft industry's first electronic automatic pilot. He conceived a means of adapting electronic temperature control principles to the automatic control of flight in 1940. This concept led to the establishment of Honeywell's Aeronautical Division the following year. Mr. Gille is credited with the engineering and development work leading to 73 Honeywell patents in the automatic controls field. His first contribution was a quiet solenoid to replace a noisy a-c solenoid previously used for gas valve operation in domestic heating. This was followed by rearrangement of a relay circuit that reduced the number of contacts necessary to perform control function. Mr. Gille served as chief engineer of product and chief test engineer, respectively, in the company's Temperature Controls Division before assuming duties in 1941 as chief engineer of the then newly formed Honeywell Aeronautical Division. As chief engineer in Minneapolis from 1945 to 1948, he was in charge of all design and test engineering for both aeronautical and temperature control activities. Since being named chief staff engineer in 1948, he has worked with the company's various divisions throughout the country in co-ordinating engineering activities and providing assistance in solving troublesome design problems. Mr. Gille is a member of the Society of Automotive Engineers, National Society of Professional Engineers, and the Institute of Radio Engineers. He was charter treasurer of the Minnesota Association of Professional Engineers, and is a past chairman of the Minnesota Section of the AIEE.

Shirley Leroy Goldsborough (AM '24, M '43), retired, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the art of high-speed relaying and telemetering of power systems." Mr. Goldsborough was born in Nephi, Utah, on May 6, 1896. He received the B.S. degree in E.E. from the University of Utah in 1921. After graduation, he joined the Westinghouse Electric Corporation where he was assigned to supply engineering and worked on the design of protective relays. In 1925, he was transferred to the Newark Works of Westinghouse as resident engineer. In 1929, when the relay engineering activity was transferred to Newark, Mr. Goldsborough was appointed section engineer in charge of the design and application of protective relays. He continued in relay engineering work until 1941 when he was made a senior design engineer on high-speed relays and telemetering. In 1951, he was made a general engineer where his activities included general relay problems and long-range development of new relays and relaying systems. He continued in this work until his retirement in 1957. Among his contributions to the field are pioneering in the design and development of high-speed impedance and reactance relays using a bean-type impedance unit and an inductor-loop directional unit. First application of distance relays to a powerline-carrier pilot channel, and development of a single-pole relaying system for distance-carrier transmission line relaying. Also, design of a reactance ground relaying system operating on zero-sequence quantities. Mr. Goldsborough served on the AIEE Protective Devices Committee (1931-37). He is the author of nine AIEE papers and many other technical articles, and has given numerous talks on relaying at AIEE District meetings. He holds 45 U.S. patents and was awarded a "Most Meritorious Patent Disclosure" award by Westinghouse a few years ago for an important contribution to a new relaying development. Since his retirement in 1957, he has lived in Vista, Calif.

Joseph Voris Lamson (AM '29, M '42), area engineer, Seattle Area, Bonneville Power Administration, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to transmission design." Mr. Lamson was born in Evanston, Ill., on March 26, 1902. He received the degree of B.S. in E.E. in 1926 from the University of Washington. After graduation he was employed by the General Electric Company in the test department. For two years he was employed by the Milwaukee Railroad, electrification department, Seattle, where he became interested in improving methods of locomotive current collection. In 1930, he became an instructor in general engineering at the University of Washington during which time he continued the study of current collection methods. This resulted in the development of collector improvements, an AIEE prize paper on the subject, and two patents of which he is co-owner. He was also employed by the Ohio Brass Co., to assist in the development of collectors for trolley busses. He received the degree of M.S. in E.E. in 1936 from the University of Washington. Since 1938, Mr. Lamson has been employed by the Bonneville Project and its successor the Bonneville Power Administration. His initial work was preparation and review of specifications for major equipment, and for construction contracts. He took an active part in standardization of power transformers and switchgear to facilitate interchangeability throughout the system. Subsequently, he served as district engineer in the Lower Columbia and Puget Sound Districts. In 1952, he became area engineer of the Seattle Area which includes approximately the western half of the State of Washington. In these positions, he has taken an active part in planning of new 115-, 230-, and 345-kv lines, a 25-kv submarine cable and numerous substations ranging in size from 3- to 500-mva capacity. Mr. Lamson is a past chairman of the Seattle Section of the AIEE, has just completed 3 years' service as AIEE representative on the Puget Sound Engineering Council, has been an officer of the Council, and is a registered professional engineer in the State of Washington.

Clifford Braswell McManus (M '47), chairman of the board and director of The Southern Company, and vice-president and director of Georgia Power Company, Atlanta, Ga., has been transferred to the grade of Fellow in the AIEE " . . . for contributions to reinforcement and expansion of electric utility systems serving a large area." Mr. McManus was born in Smithville, Ga., on November 14, 1895. He graduated from Alabama Polytechnic Institute in 1916 with a B.S. degree in engineering. After graduation, he enrolled in the student course at Westinghouse Electric Corporation. In 1917, he joined

The Ludi Studio

C. B. McManus

E. J. Merrell

T. W. Schroeder

the Alabama Power Company as a relay engineer. During World War I, he served in the Corps of Engineers, after which he returned to the Alabama Power Company. In 1921, he was named superintendent of the Muscle Shoals steam electric plant where he directed plant operations. From 1923 to 1927, he managed the Western Division and then the Northern Division of the Alabama Power Company. He transferred to the Georgia Power Company as assistant operating manager in 1927 and during the next 18 years, took a leading part in the planning and rapid expansion of the company system. In 1945, he was named assistant to the president of the Georgia Power Company and soon afterward was made vice-president and director of operations. In 1947, he was elected president. In 1950, he became president of The Southern Company, the parent company of Georgia, Alabama, Gulf, and Mississippi Power Companies. In 1951, he was named administrator of the Defense Electric Power Administration and had the responsibility of seeing that the nation's electric power supply met the national defense needs. Returning to The Southern Company as president, he directed the affairs of this company in its continued expansion. At the beginning of 1957, he became vice-chairman of the board of directors and on October 28, 1957, was elected chairman. In 1951-52, he served as president of the Southeastern Electric Exchange. He is a director of the Edison Electric Institute, a trustee of the Southern Research Institute, and a member of the Georgia Engineering Society.

Edwin Joseph Merrell (AM '41, M '47) chief engineer, Phelps Dodge Copper Products Corporation, Yonkers, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the art of high-voltage cables." Mr. Merrell was born in New York, N. Y., on April 2, 1913. He received the B.S. degree in engineering from Princeton University in 1935 and completed study for the graduate degree of Electrical Engineer the following year under the Orson D. Munn Fellowship. Mr. Merrell joined the Phelps Dodge Copper Products Corporation Habirshaw Division in 1936 and, after a period in manufacturing, was made a member of the Research Laboratory staff. He became director of electrical research in 1947, and in 1956 succeeded W. A. Del Mar as chief engineer in charge of cable engineering and research. Mr. Merrell holds 4 patents, has been author or co-author of 12 AIEE papers as well as papers for other societies, and has presented AIEE education courses on pipe cable and aluminum sheath power cable. Mr. Merrell has been a leader in the development and use of polyethylene for cable insulation, sheaths, and jackets; and in the development of aluminum for sheaths, of communication and power cable, and of methods of making joints therein, especially the "mechanical" type of joint. He has had charge of the development of the two highest voltage cable systems in the United States, both for 230,000 volts, one a pipe cable at Garrison Dam, N. D., and the other an oil-filled cable on the Niagara–Mohawk system. Mr. Merrell is a member of the AIEE Insulated Conductors Committee (1956-59), presently serving as secretary. He was a vice-president of the Insulated Power Cable Engineers Association and is chairman of its Shielding Committee. He is a member of the Technical Steering Committee of the Cable Sheathing Task Group of the Lead Industries Association, and the Steering Committee of the AEIC–EEI 345-Kv Cable Test Project. He is a registered professional engineer and holds membership in the (British) Institution of Electrical Engineers, Sigma Xi, Insulation Conference of the National Research Council, Princeton Engineering Association, and The Engineers' Club of New York.

Theodore Wilson Schroeder (AM '37, M '44), chief electrical engineer, Illinois Power Company, Decatur, Ill., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to planning and design of power systems." Mr. Schroeder was born in Omaha, Nebr., on December 17, 1913. He graduated from the University of Nebraska in 1936 with the B.S. degree in E.E. He then entered the General Electric Company student engineer's program and was assigned successively to the motor generator engineering department and control station engineering department. He was responsible during the early part of the latter assignment for network analyzer studies of electric utility systems and later for general application engineering for utilities, particularly the application of capacitors to power systems. In 1945, he became consulting engineer for the United Light and Railways Service Co., Davenport, Iowa, former holding company, where his principal work was planning and design of facilities for an extensive interconnection of the properties and system planning for them. In 1949, he became system planning engineer for the Iowa Power and Light Co., Des Moines, Iowa, and later acting head of the power Plant Engineering Division. In 1952, he was appointed assistant chief electrical engineer of the Illinois Power Company, with responsibility for planning, design, and construction of electric system facilities exclusive of design and construction of power plants. He was appointed chief electrical engineer in 1955. Mr. Schroeder is a registered professional engineer, and a member of the Edison Electric Institute (EEI), Sigma Xi, Sigma Tau, Pi Mu Epsilon, and Eta Kappa Nu. He is a past chairman of the AIEE Iowa Section and has served on the AIEE System Engineering Committee (1953-58). He is a member of the EEI System Planning Subcommittee and has been chairman of the EEI Project Group on Load Forecasting and Pro-

P. C. Smith

Laurence Wylie

ject Group on Economic Comparison of Alternative Facilities. He is the author of a number of technical articles..

Philip Carver Smith (AM '26, M '48), assistant general manager, East Pittsburgh Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design and development of large motors and generators." Mr. Smith was born January 16, 1900, in Capron, Va. He graduated from the University of North Carolina with a degree in electrical engineering in 1921. He then joined the Westinghouse Electric Corporation on the graduate student training course. After a number of shop assignments, he attended the Westinghouse Engineering School and in 1925, was selected for the Design School, a concentrated 6-months course in the design of company products. He then entered the power engineering department and for a number of years was engaged in the design of large motors, principally induction type for use in steel mills, wind tunnels, pipe lines, and general industrial applications. In 1943, he was appointed section manager of engineering on a project involving portable power trains. This project consisted of designing and building 34 units of 1,000-kw to 5,000-kw capacity and covered all elements from coal to kw output. All of the equipment was mounted on railroad cars. In 1945, he was made assistant to the division manager of the Westinghouse Transportation and Generator Division in East Pittsburgh. This division of the East Pittsburgh operation was responsible for sales, engineering, and manufacture of large motors and generators, both a-c and d-c type, traction equipment, and mercury-arc rectifiers. In 1952, he was made manager of the Transportation and Generator Division, and in 1957, became assistant general manager of the East Pittsburgh Division. In 1952, he received the Westinghouse Order of Merit. He is a registered professional engineer in the State of Pennsylvania.

Laurence Wylie (M '48), consulting electrical engineer, Seattle, Wash., has been transferred to the grade of Fellow in the AIEE ". . . for pioneering contributions to the design, construction, and operation of an electrified railroad and its equipment." Mr. Wylie was born June 30, 1891, in Bozeman, Mont. He received the B.S. degree in 1913 and the professional E.E. degree in 1920, both from Montana State College. After graduation in 1913, he served for 2 years on the engineers apprentice course given by Westinghouse at East Pittsburgh, Pa. In May 1915, he returned to Montana to accept employment in the electrification department of the Chicago, Milwaukee, St. Paul and Pacific (C.M.St.P. & P.) Railroad, which had just started a program to electrify 440 miles of the main line in Montana and Idaho. During World War I, he enlisted in the Aviation Section of the Signal Reserve Corps, U. S. Army, and served overseas. In 1919, he returned to the electrification department of the C.M.St.P. & P. Railroad as assistant engineer. In 1936, he transferred to the operating department of the Railroad and served successively as trainmaster, assistant superintendent, and division superintendent. During the period of World War II, he was superintendent of the Coast Division of the railroad. In January 1948, he returned to the electrification department of the Railroad as electrical engineer in charge of power lines and power conversion substations. During the 1948-56 period, he inaugurated and completed various projects for improvement of the electrification system of the C.M. St.P. & P. Railroad, including revision of power contracts, rehabilitation of electric locomotives, purchase of new electric locomotives, installation of equipment for automatic operation of power substation equipment, and rehabilitation of power transmission and trolley distribution systems. In June 1956, he retired from his position as electrical engineer with the railroad and entered into practice as a consulting electrical engineer. Mr. Wylie is a registered professional engineer in the State of Washington and a member of the National Society of Professional Engineers. He served on the AIEE Land Transportation Committee (1949-57).

AIEE PERSONALITIES

M. J. Kelly (M '26, F '31), chairman of the board of Bell Telephone Laboratories, New York, N. Y., was named by the National Security Industrial Association (NSIA) to receive its 1958 James Forrestal Memorial Award. The gold medal and citation were presented January 29, 1959, at the NSIA Forrestal Dinner. Dr. Kelly, who served as president of Bell Telephone Laboratories since 1951, was recently elected chairman of the board of directors. In recognition of his World War II contributions, Dr. Kelly was awarded the Presidential Certificate of Merit. Since then he has held many public service assignments in Washington, D. C., particularly with the Atomic Energy Commission, the Department of Commerce, and the Department of Defense. Among his many honors are the U.S. Air Force Exceptional Service Award and the 1953 Trophy of the Air Force Association. He is a member of the National Academy of Sciences and a fellow of the American Physical Society, the Acoustical Society of America, and the Institute of Radio Engineers. Dr. Kelly has served on the following AIEE Committees: Communication (1934-37); Standards (1934-43); Basic Sciences (1937-46); Lamme Medal (1940-43); Research (1940-45, 1947-51, chairman 1949-51); Award of Institute Prizes (1949-51); Technical Program (1949-50).

S. W. Bruun (AM '40, M '46), consulting illuminating engineer, Ridgewood, N. J.; **J. L. Cox** (AM '46, M '52), vice-president in charge of engineering, Duro Test Corporation, North Bergen, N.J.; and **R. L. Zahour** (AM '53, M '55), manager, Illuminating Engineering Section, commercial engineering department, Westinghouse Electric Corporation, Bloomfield, N. J., have been elevated to the rank of Fellow in the Illuminating Engineering Society. Mr. Bruun has served on the AIEE Production and Application of Light Committee (1949-50, 1951-57). Mr. Zahour is a member of that same Committee (1955-59).

M. S. Coover (AM '16, F '42, Member for Life), past president of AIEE, 1956-57, and administrative assistant, Division of Engineering, Iowa State College, Ames, Iowa, has been named dean emeritus of the Division of Engineering. For the present, he will continue to serve as acting head of the department of civil engineering, the position he has held since September 1957. Born in Shippensburg, Pa., Dr. Coover received the E.E. degree in 1914, and an honorary D.Eng. degree in 1957, both from Rensselaer Polytechnic Institute. He joined the staff of Iowa State College in 1935 as professor and head of the electrical engineering department. Dr. Coover is a member of the American Society for Engineering Education, Iowa Engineering Society, Institute of Radio Engineers, and National Society of Professional Engineers. He is also a member of Phi Kappa Phi, Tau Beta Pi, Eta Kappa Nu, and Sigma Tau. Dr. Coover served as AIEE vice-president for District No. 5, 1944-46, as a director of the Institute, 1940-44, 1955-58, and as member or chairman of numerous AIEE Committees, including the following: Sections (1937-46, chairman 1940-42); Education (1937-43, 1944-56); Research (1937-40); Planning and Co-ordination (1940-42); Edison Medal (1941-43, 1944-46, 1955-59); Publication (1944-48); Engineers Council for Professional Development (1945-52); Washington Award Commission (1946-48); Code of Principles of Professional Conduct (1954-55); Lamme Medal (1955-56); Registration of Engineers (1955-56); Executive (1956-59, chairman 1956-57); Recognition Awards (1957-60); John Fritz Medal (1957-61); AIEE-IRE Co-ordination Committee (1957-58).

G. R. Town (AM '28 F '54) has been named dean of the Division of Engineering at Iowa State College, effective March 1, 1959. Born in Poultney, Vt., Dr. Town received the electrical engineering degree from Rensselaer Polytechnic Institute in 1926, and the degree of D. Eng. in 1929. After experience with Leeds & Northrup Company, Arma Engineering Company, and Stromberg-Carlson Company, he joined the staff at Iowa State College in 1949 as associate director of the Iowa Engineering Experiment Station and professor of electrical engineering. From January 1957 to August 1958, Dr. Town was on leave from the College to serve as executive director of the Television Allocations Study Organization. He is a fellow of the Institute of Radio Engineers and the Iowa Engineering Society. He is a member of the American Society for

Engineering Education, Phi Kappa Phi, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. Dr. Town is a member of the AIEE Television and Aural Broadcasting Systems Committee (1952-59) and Electronics Committee (1956-59).

J. E. Lagerstrom (AM '27, M '54) has been named assistant dean of engineering for academic teaching at Iowa State College, effective January 1, 1959. Dr. Lagerstrom was born in Galesburg, Ill., and received the B. S. degree in 1944, the M.S. in 1951, and the Ph.D. in 1958, all from Iowa State College. He has been on the faculty since 1946. One of his chief interests has been the network analyzer, used by producers of electrical power to help solve the intricate problems involved in the distribution of that power over complex systems. Dr. Lagerstrom is a member of the AIEE Transmission and Distribution Committee (1952-59).

J. J. Kearney (AM '49), assistant managing technical editor of *Electrical World* magazine, a McGraw-Hill publication, has been appointed staff assistant and secretary of the Committee on Atomic Power of the Edison Electric Institute.

M. L. Manning (AM '36, F '48), staff engineer, Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa., has been appointed dean of engineering and director of the Engineering Experiment Station at South Dakota State College, College Station, Brookings, S. Dak. An authority on electrical insulation, Dean Manning has been active on committees of the American Society for Testing Materials and the National Electrical Manufacturers Association. He has served on the following AIEE Committees: Transformers (1949-50), Electrical Insulation (1955-59), and Education (1958-59).

A. M. Musgrove, Jr., (AM '30, F '45), Colonel, USAF, has been reassigned from Deputy Chief of Staff, Installations (Engineer), Headquarters Continental Air Command, Mitchel AF Base, New York, to Officer-in-Charge of Air Force military construction for bases in the South Atlantic area, Puerto Rico, and the Carribean area. Col. Musgrove served as a member of the AIEE Transfers Committee (1947-48).

H. N. Stover (M '40), of Gould-National Batteries, Trenton, N.J., has been appointed assistant vice-president for industrial sales. Mr. Stover has served as a member of the AIEE Standards Committee (1940-50), Electro-chemistry and Electrometallurgy Committee (1940-43), and as liaison representative on the Standards Committee (1951-54).

I. M. Stein (AM '18, F '39, Member for Life), president of Leeds & Northrup Co., Philadelphia, Pa., has just completed his 40th year with the company. He joined the organization as a sales engineer, and moved upward through various responsibilities which included a long period as director of research. In 1951, he was elected to the position of executive vice-president, and two years later he became president. Mr. Stein holds a Presidential Certificate of Merit for work with the Office of Scientific Research and Development during World War II. He is a fellow of the American Society of Mechanical Engineers and the American Association for the Advancement of Science, and a Distinguished Life Member of the American Society for Metals. He has served as an AIEE vice-president, 1937-39, and on numerous AIEE Committees, including: Sections (1921-41, chairman 1933-36); Publication (1934-42, chairman 1936-40); Technical Program (1936-41); Constitution and Bylaws (1938-46, chairman 1941-44); Lamme Medal (1941-44, 1957-60); Science and Electronics Division (1948-53); Edison Medal (1946-51).

Victor Wouk (AM '43, M '52) has been named vice-president and director of research and advanced development of Sorensen & Company. Dr. Wouk is serving on the AIEE Electronics Committee (1955-59). He is a member of the American Institute of Physics and the Institute of Radio Engineers.

D. N. Culver (AM '36, M '44), Toronto area plant supervisor, The Bell Telephone Company of Canada, has been appointed general defense co-ordinator of the company with headquarters in Montreal. Mr. Culver serves as secretary of AIEE District No. 10, Canada. He formed and was the first chairman of both the Communications Study Group in Toronto, and the Institute's London, Ont., Subsection.

H. A. Dunn (AM '50), salesman in the State of Washington, RT&E Corporation, has been named sales manager, Pacific coast. His headquarters will be at the company's branch plant in Portland, Oreg.

J. A. Gagas (AM '50) has been promoted to staff engineer in the DPM Product Engineering Department of the International Business Machines Corporation Product Development Laboratory at Poughkeepsie, N. Y., where he has been engaged in electrical design work on a new data-processing unit.

Alex Gruenwald (AFFIL '56), cable engineer, Long Island Lighting Company, has been appointed by Jerome Hydraulics Company of Mineola, N. Y., to head research and technical writing.

R. G. Burns (AM '36), has retired from active representation of Allis-Chalmers Manufacturing Company in the Rochester (N. Y.) area after 30 years of continuous service. In continuing his other sales activities in Rochester, Mr. Burns will act as consultant to the Allis-Chalmers Rochester district office.

Raymond Kendall (AM '52), Eastern District microwave sales manager, Motorola, Inc., has been named product sales manager, communications systems, Government Relations, Government Equipment Division, Raytheon Manufacturing Company.

H. W. Middlecoff (AM '42), engineering group leader, North American Aviation, Autonetics Division, Downey, Calif., has been appointed chief engineer of Dressen-Barnes Corp., Pasadena, Calif.

Z. W. Pique (M '49) is now serving as director of sales for Hughes Products Group of Hughes Aircraft Company, Los Angeles, Calif. In the newly created post, Mr. Pique is responsible for developing sales policy and administering marketing, advertising, and Government sales and contracts.

Olan Richardson (M '42, F '56), former president of Southern States Equipment Corporation, Hampton, Ga., has been elected chairman of the board. His duties will be those of chief executive officer.

W. H. Ruese (M '36), superintendent of electrical operations of Ohio Valley Electric Corporation, Chillicothe, Ohio, has been elected vice-president in charge of operations of the company.

T. R. Ryan (AM '43) has been appointed sales and application engineer, Northeastern District, for the Triangle Conduit and Cable Company, Inc., of New Brunswick, N. J. Mr. Ryan has been active in the New York Section of the AIEE.

F. R. Terrant (AM '41, M '48), assistant manager of engineering for the Ivanhoe Division of the Reliance Electric and Engineering Company, Cleveland, Ohio, has been named manager of engineering of the division. Mr. Terrant is a member of the AIEE Rotating Machinery Committee (1952-59).

S. B. Lamica (AM '58), sales representative in Allis-Chalmers, Tampa, Fla., district, has been appointed manager of the Jacksonville, Fla., district of Allis-Chalmers Industries Group. He succeeds **J. T. Graham** (AM '52), who has been named supervisor of sales training for the Industries Group with headquarters in Milwaukee, Wis.

David Talley (M '41) has transferred from the Active to the Retired Reserve of the U. S. Army Signal Corps after a 32-year career with the Corps which included 5 years of active duty during World War II. Col. Talley is director of radio engineering for the telecommunications operating group of International Telephone & Telegraph Corporation. He is a member of the AIEE Radio Communications Systems Committee (1950-59, chairman 1958-59) and Communications Division (1958-59).

E. A. Link (AM '43), chief engineer, RT&E Corporation, Waukesha, Wis., has been promoted to vice-president in charge of engineering. Mr. Link holds a masters degree in electrical engineering from the University of Illinois and is a registered professional engineer in the State of Wisconsin.

J. S. Smith (AM '49, M '55), supervisor of transmitter design for two-way radio units, Communication Products Department, General Electric Company (GE), has been named manager of standard mobile design engineering, with responsibility for co-ordinating design activities on new GE products.

R. C. Stiles (AM '51, M '57), senior project engineer for General Telephone Laboratories, Northlake, Ill., received the Talbot G. Martin Award from the Automatic Electric Company ". . . in recognition of his outstanding contribution to the art and science of communications through the design and development of teletypewriter switching systems."

D. G. Wilson (AM '40, M '49), associate director of research and advanced development, Stromberg-Carlson, a division of General Dynamics Corporation, Rochester, N. Y., has been appointed general manager of the San Diego (Calif.) facility of Stromberg-Carlson's Electronics Division. Dr. Wilson has served on the following AIEE Committees: Electronics (1949-59, chairman 1957-59); Instruments and Measurements (1953-55); Special Instruments and Auxiliary Apparatus (1956-57); Science and Electronics Division (1957-59); Education (1958-59); Registration of Engineers (1958-59); Electrical Techniques in Medicine and Biology (1958-59); and Research (1958-59).

F. C. Anderson (AM '44), chief engineer, Storage Battery Division, Thomas A. Edison Industries, has been appointed to the engineering staff of NICAD Division of Gould-National Batteries, Inc., Easthampton, Mass.

R. L. Biesele, Jr. (AM '45, M '48), chief electronics engineer, Fenwal, Inc., Ashland, Mass., has been appointed chief applications engineer, Shockley Transistor Corporation, Palo Alto, Calif. Mr. Biesele served on the AIEE Education Committee (1949-52).

B. A. Crosson (AM '52), superintendent of maintenance, Teachers College, Columbia University, has resigned to take on a position as maintenance specialist at Marquardt Aircraft Co. in the Test Facilities Division of the Ramjet Engine.

C. K. Fennel (AM '53), manager of sales education and training, Apparatus Sales Division, General Electric Company, Schenectady, N. Y., has joined Texas Instruments, Inc., as manager of marketing techniques.

D. G. Fink (M '45, F '51), director of research, Philco Corporation, Philadelphia, Pa., received the first Technological Award of the Year from the New York Institute of Technology. The award is given for outstanding contributions made by a scientist in industry toward improving technological training standards. Mr. Fink served on the AIEE Electronics Committee (1947-57) and Television and Aural Broadcasting Systems Committee (1950-52).

E. I. Green (AM '23, F '46, Member for Life), vice-president in charge of systems engineering, Bell Telephone Laboratories, was named executive vice-president. Mr. Green has a long record of distinguished engineering experience and achievement, including more than 70 patents granted for his inventions. He is a fellow of the Institute of Radio Engineers, and a member of the Acoustical Society of America, the American Physical Society, the Operations Research Society of America, and the American Association for the Advancement of Science. Mr. Green has served on numerous AIEE Committees, including the following: Instruments and Measurements (1942-50, chairman 1947-49); Standards (1947-50); Technical Program (1947-49, 1951-52); Communication and Science Co-ordinating (1947-49); Science and Electronics Division (1950-54, chairman 1950-52); Technical Advisory (1950-52); Technical Operations (1952-56); Planning and Co-ordination (1952-59); Award of Institute Prizes (1952-56, chairman 1952-54); Engineering Foundation (1955-58); Publications (1957-58); Education (1958-59); Members-for-Life (1958-59).

N. I. Hall (M '56), vice-president and director of systems development laboratories, Hughes Aircraft Company, Culver City, Calif., has been named vice-president in charge of engineering.

K. B. Muenter (M '48), chief electrical engineer, Switchgear and Box Division, Robertson Electric Co., has been appointed manager of the division.

R. N. Nicola (AM '50), vice-president and chief engineer, Newton Company, Manchester, Conn., has been named president of the company.

J. M. Pearce (M '50), vice-president and general manager of The Hoover Electronics Company, Timonium, Md., has been appointed manager of electronics requirements by The Martin Company, Baltimore, Md.

C. G. Smith (AM '20, M '26, Member for Life), 70-year-old radio pioneer and one of the three founders of Raytheon Manufacturing Company, retired January 1 from that company. Dr. Smith retired after a lifetime of work and inventions in electronics, during which he has earned more than 150 patents. He is a member of the American Physical Society and the American Association for the Advancement of Science.

W. H. Surber (AM '43, M '54) of the electrical engineering department, Princeton University, has been appointed a consultant of General Devices, Inc., Princeton, N. J. Prof. Surber is well known for his work in the fields of microwave measurements, nonlinear systems, and feedback control systems.

A series of executive promotions in the engineering department of American Electric Power Service Corporation, New York, N. Y., became effective January 1. In the Electrical Engineering Division, **F. M. Porter** (AM '36, M '45), division head, became consulting electrical engineer. He is succeeded as division head by **C. P. Zimmerman** (AM '40, M '58), Electrical Equipment Section head. **H. C. Barnes** (AM '47, M '54), Relay Section head, moved up to assistant division head and is succeeded by **Arthur Hauspurg** (AM '48, M '56), acting section head. The System Planning and Operating Division became two divisions. **H. P. St. Clair** (AM '22, F '44, Member for Life), its manager, became consulting planning and operating engineer. **T. J. Nagel** (AM '39, M '50), System Planning Section head, moved up to System Planning Division head, and **C. A. Imburgia** (M '48), head of the planning and Technical Studies Section, became assistant division head. **G. H. McDaniel** (M '46), head of the System Operating Section, was promoted to head of the System Operating Division. Mr. Porter is a member of the AIEE Rotating Machinery Committee (1953-59). Mr. Zimmerman is a member of the AIEE Switchgear Committee (1954-59). Mr. Barnes is a member of the AIEE Relays Committee (1952-59). Mr. St. Clair has served on the following Institute Committees: Protective Devices (1940-45), Board of Examiners (1952-58), Transmission and Distribution (1952-59). Mr. McDaniel has been a member of the following AIEE Committees: Power Generation (1946-50, 1956-59); System Engineering (1949-55); Rotating Machinery (1954-56).

S. W. Herwald (AM '46, M '49), manager of the Westinghouse Electric Corporation Air Arm Division, Baltimore, Md., has been elected vice-president in charge of research. Mr. Herwald has served on the AIEE Feedback Control Systems Committee (1949-59, chairman 1950-52) and Industry Division (1950-52).

R. A. Oldham (M '46) has been appointed chief engineer of Triangle Conduit & Cable (Canada), Ltd. From 1956 to 1958, Mr. Oldham was associated with Crompton Parkinson's Derby Cable Works and Enfield Cables' Operations in London, England, studying European practices and gaining experience in the special cable field.

The following AIEE members are among those recently named Fellows of the Institute of Radio Engineers: **S. J. Angello** (AM '42, M '51), Westinghouse Electric Corp., Pittsburgh, Pa.; **Maurice Apstein**

Bimonthly Publications

The bimonthly publications, *Communication and Electronic Applications and Industry* and *Power Apparatus and Systems* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. Members may receive one subscription to any *one* of the bimonthlies for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers, and subscription agencies.

(M '53), Diamond Ordnance Fuze Laboratories, Washington, D. C.; **J. M. Barstow** (AM '35, M '51), Bell Telephone Laboratories, Murray Hill, N. J.; **C. C. Chambers** (AM '35, F '51), vice-president, engineering affairs, University of Pennsylvania, Philadelphia, Pa.; **H. F. Dart** (AM '20, F '58), Westinghouse Electric Corp., Elmira, N. Y.; **D. K. Gannett** (AM '20, M '30), Bell Telephone Laboratories, Murray Hill, N. J.; **J. W. E. Griemsmann** (AM '39), associate director, Microwave Research Institute, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.; **L. N. Holland** (M '43), professor of electrical engineering, University of Michigan, Ann Arbor, Mich.; **Heinz Horn** (M '56), vice-president, Felten & Guilleaume Carlswerk AG, Koln-Mulheim, Germany; **T. P. Kinn** (M '44), president and general manager, Kinn Electronics Corp., Baltimore, Md.; **W. R. Le Page** (AM '34, M '44), chairman, electrical engineering department, Syracuse University, Syracuse, N. Y.; **J. H. Mulligan, Jr.** (AM '44, M '54), professor and chairman, department of electrical engineering, New York University, New York, N. Y.; **T. M. Odarenko** (AM '42), scientific consultant, U. S. Government, Washington, D. C.; **R. W. Olson** (M '56), vice-president, research and engineering, Texas Instruments, Inc., Dallas, Texas; **P. F. Ordung** (AM '43, M '54), Yale University, Dunham Laboratories, New Haven, Conn.; **R. D. Parker** (AM '07, F '46, Member for Life), consulting engineer, Washington, D. C.; **Eugene Peterson** (M '26, F '51), consultant, New York, N. Y.; **H. P. Schwan** (AM '52, M '55), professor, Schools for Electrical Engineering & Medicine, University of Pennsylvania, Philadelphia, Pa.; **O. J. M. Smith** (AM '42, M '47), associate professor, Electrical Engineering Division, University of California, Berkeley, Calif.; **J. G. Truxal** (AM '51, M '54), head, electrical engineering department, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.; **J. H. Vogelman** (M '49), technical director, directorate of communications, Rome Air Development Center, Griffiss Air Force Base, N. Y.

OBITUARIES

Benjamin P. Baker (AM '38, M '41, F '48), consulting engineer, switchgear apparatus department, Westinghouse Electric Corporation, East Pittsburgh, Pa., died recently at the age of 60. Born at Winchester, Va., April 29, 1898, Mr. Baker was graduated from Lebanon Valley College in 1919, and a year later received an E.E. degree from the University of Virginia. He taught physics at the University of Pittsburgh for 4 years, working summers in the Westinghouse Research Laboratories. In 1924, he joined Westinghouse to work on circuit interruption problems under Dr. Joseph Slepian in the Engineering Laboratories. He transferred to the circuit breaker department in 1929. In 1939, he received the Westinghouse Order of Merit, the company's highest award, with a citation reading ". . . for his originality in the development of switchgear; for his unique capacity for translating new fundamental discovery into commercial apparatus." Mr. Baker was made a consulting engineer in 1949 and received two Special Patent Awards of $5,000 each in 1952 and 1957. He had been awarded 104 patents with some 18 more still pending. He had presented many papers before the Institute on the subject of arc quenching and circuit breaker design.

R. B. Cruise (AM '43), right-of-way engineer for Gulf States Utilities Company, Beaumont, Tex., died recently at the age of 60. Born in New London, Conn., Mr. Cruise graduated from Brown University. He began his utility career with Stone & Webster in 1922 and continued with Gulf States when that firm was organized out of Stone & Webster. He went to Beaumont in 1927. Mr. Cruise was a veteran of service in World War I and was active in the American Legion. He was a member of the Texas Guard and was active in civil defense work.

Waldo V. Lyon (AM '07, F '33), professor emeritus, Massachusetts Institute of Technology (MIT), died in April 1958. He had been an active member of the MIT staff for 47 years, from his graduation in 1905 until his retirement in 1952. Prof. Lyon was widely known for his studies of a-c machinery, properties of conductors, and other electrical problems involving mathematical analysis, and was the author of such books as "Problems in Electrical Engineering," "Problems in Alternating Current Machinery," and "Applications of a Method of Symmetrical Components." After serving as assistant and instructor in electrical engineering, Prof. Lyon was promoted to assistant professor in 1916, associate professor of electrical machinery in 1922, and professor of electrical machinery in 1929. He was a lecturer at MIT from 1947 to 1952. Prof. Lyon served on the AIEE Electrical Machinery Committee (1932-34).

Richard Frederick Price (M '58), electrical engineer, Stearns-Roger Manufacturing Company, Denver, Colo., died recently. Mr. Price was born in Columbus, Ohio, on February 23, 1910. He received the B.S. degree in E.E. in 1935 from the University of Colorado. Mr. Price was a registered professional engineer in the States of Colorado, Nebraska, and California, and a member of the Pacific Coast Electric Association. He had been employed by Stearns-Roger Manufacturing Company since 1948.

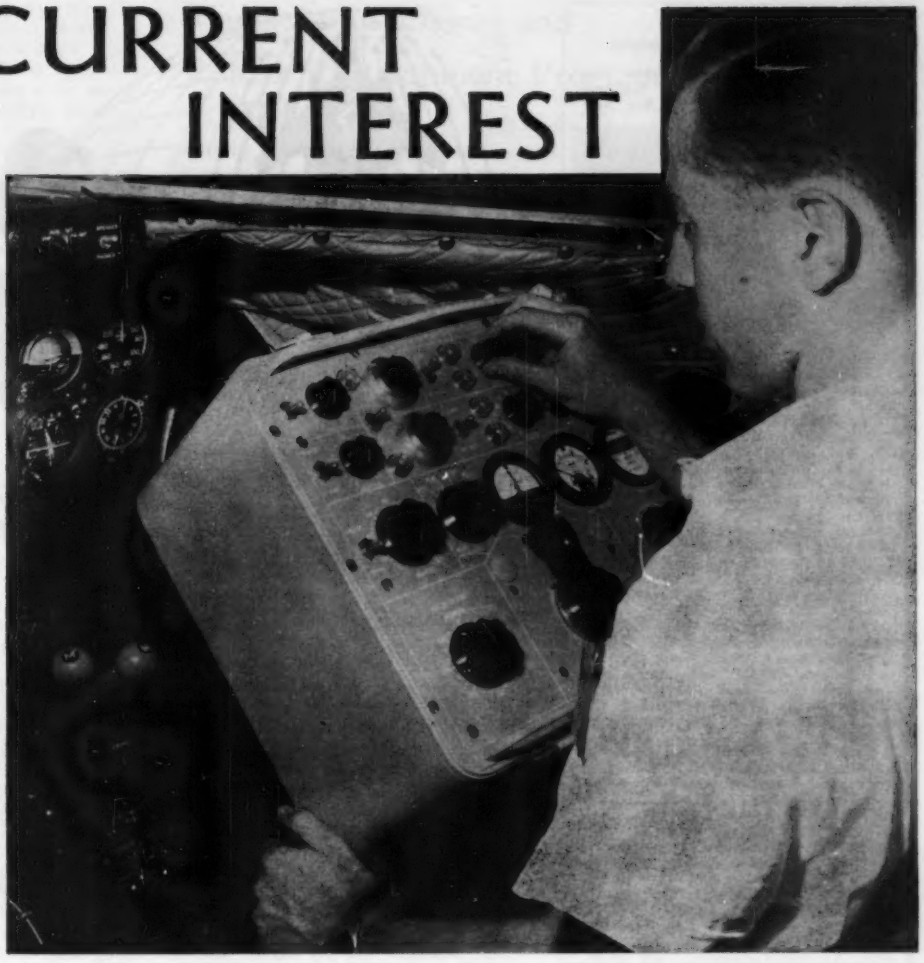
Charles S. Redding (AM '12, M '41, F '48, Member for Life), chairman of the board of directors and former president of Leeds & Northrup Company (L&N), Philadelphia, Pa., died recently. He was 75. Mr. Redding had spent practically his entire business career with L&N. Born in Philadelphia, he joined the then Morris E. Leeds Company as a draftsman in 1901. He soon entered the University of Pennsylvania, graduating in 1906 with the degree of B.S. in E.E. After teaching for two years, he rejoined L&N in 1909 as a salesman. In 8 years, Mr. Redding became associate sales manager and shortly afterwards second vice-president. His next step was assistant treasurer, then vice-president and treasurer in 1922. In 1924, he became treasurer and factory manager, and in 1928, vice-president of engineering and development. Mr. Redding was president of L&N from 1939 to 1953, when he became chairman. From 1941 to 1946, he was also president of the Franklin Institute; and, from 1949 through 1951, he was president of the Scientific Apparatus Makers of America. He was an honorary D.Sc. of the University of Pennsylvania. Mr. Redding was a member of the American Physical Society and the American Association for the Advancement of Science.

Glen Appleman (AM '20, M '30, Member for Life), retired, of Princeton, Mo., died recently. Mr. Appleman was born on July 10, 1889 in Pennsylvania. Before he entered college, he gained experience with several firms including American Car and Foundry Company; Berwick Electric Light, Heat, and Power Company; Fishing Creek Valley Milling Company; Dauphin Electrical Supply Company; and Benton Electric Company. In 1918, Mr. Appleman received a B.S. Degree in E.E. from Pennsylvania State College where he was elected to Eta Kappa Nu and Tau Beta Pi. He then joined the Pennsylvania Power & Light Company where he was employed for many years.

Albert Frederick Edel (M '37, Member for Life), of the Pennsylvania Power & Light Company, died recently. Capt. Edel was born in Richmond, Va., on April 19, 1889. He attended the University of Virginia where he received the M.E. and E.E. degrees. After a year with the Western Electric Company, he joined Electric Bond and Share Company in 1916. He served in the U. S. Navy during World War I, and was discharged as a lieutenant commander in the Naval Reserve. He returned to Electric Bond and Share in 1919. In 1921, he joined Pennsylvania Power & Light Company. Capt. Edel was a member of the U.S. Naval Institute. He had served on committees of the Pennsylvania Electric Association and the Association of Edison Illuminating Companies.

Samuel Earle Moore (AM '41, M '52) senior engineer, Philadelphia Electric Company, died recently. Mr. Moore was born March 18, 1903, in Petersburg, Va. He received the E.E. degree from Virginia Polytechnic Institute in 1926. After graduation, he was employed in the sales and customers service departments of the Chester Valley Electric Company (now Philadelphia Electric Company). He worked in various positions in the sales and customers service departments, transferring to the Electrical Engineering Division in 1941. Mr. Moore served as chairman of the Conference on Recording and Controlling Instruments in 1952 and as chairman of Arrangements for the joint AIEE–IRE (Institute of Radio Engineers) Symposium on Automation in 1954. He was a registered professional engineer, and was serving as chairman of the Working Group on Field Investigations, Subcommittee on Audible Sound, AIEE Committee on Transformers, at the time of his death.

OF CURRENT INTEREST



"EARTH TURNER" in aircraft cockpit, Sperry Gyroscope engineer Charles Hyman, turns knob to "rotate the world" about parked airplane. Average line crewman is able, in an hour or two, to remove compass errors by rotating the equivalent of the Earth's magnetic field around the aircraft instead of vice versa.

Earth "Rotates" Around Parked Plane by Use of Electronics

A REVOLUTIONARY METHOD of calibrating airborne compass systems by "rotating the world" around a parked aircraft—or guided missile—was announced recently by the U.S. Air Force (USAF) and Sperry Gyroscope Company, Great Neck, N.Y.

The new system—which the company developed under sponsorship of USAF's Wright Air Development Center, Dayton, Ohio—enables an average line maintenance man to rotate the equivalent of the earth's magnetic field about a parked aircraft for a precise check of its compass system.

Saves Time and Money

This unusual development is expected to save millions of dollars in ground maintenance and flight costs and, at the same time, give these prime navigational instruments greater accuracy than ever before.

The new equipment already has been used by the USAF and Sperry engineers to calibrate precisely the compass system for the SNARK intercontinental missile, as well as those of a variety of conventional and high-performance aircraft, including the *B-52, KC-135, B-47, F-102,* and *B-66.*

The U.S. Army and Navy, Canadian and other governments, aircraft industry, airlines, and other aircraft operators are interested in the unique development, it was stated by the company's Aeronautical Equipment Division.

Magnetic compasses must be calibrated periodically because changing metallic and electrical influences adversely affect their accuracy. Precise calibration—until now a costly, complex procedure—is of special importance with today's long-range high-speed aircraft.

This new electronic method of "swinging the earth on its axis" enables a maintenance man quickly to check the accuracy of compass indications in all directions, without moving the aircraft.

He does this simply by manipulating a switch on a small electrical console—a portable control unit plugged into the plane's compass system. With the new equipment, compasses in even the largest aircraft can be calibrated precisely in less than 2 hours.

3-Step Calibrating System

A calibration crewman places the compass' direction-sensing device—called a flux valve—in a small turntable mounted on a surveyor's tripod. This is done to align the valve with the Earth's magnetic north and to determine what electrical currents are needed to cancel "out" the natural local magnetic field.

The flux valve then is re-installed in the aircraft and aligned optically.

A second crewman, sitting in the plane's cockpit with the electrical console connected by cable to the compass system, then quickly switches to each of 24 magnetic headings (each 15° of a circle). The console provides the electric voltages and

Future Meetings of Other Societies

2nd National Lighting Exposition, Mar 1-4, Coliseum, New York, N. Y. National Lighting Expositions, 550 5th Ave, New York 36, N. Y.

American Management Association, Special Electronics Conference, Mar 2-4, Statler Hotel, New York, N. Y. AMA, 1515 Broadway, New York 36, N. Y.

The American Society of Mechanical Engineers

Gas Turbine Power Conference & Exhibit, Mar 8-11, Netherlands-Hilton Hotel, Cincinnati, Ohio. L. S. Dennegar, ASME, 29 W 39 St, New York 18, N.Y.

Aviation Division Conference, Mar 9-12, Statler-Hilton Hotel, Los Angeles, Calif. L. S. Dennegar, same.

Instruments & Regulators Division Conference, Mar 29–Apr 2, Case Inst of Tech, Cleveland, Ohio. L. S. Dennager, same.

SFSA, 57th Annual Meeting, Mar 9-10, Drake Hotel, Chicago, Ill. G. K. Dreher, SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

S.A.M.E., Northeastern Regional Meeting, Mar 10, Pittsburgh, Pa. Lt. Col. Wilfred Bauknight, 312 Newborn Dr, Pittsburgh 16, Pa.

ISA, 9th Annual Iron & Steel Conference, Mar 11-12, Pittsburgh, Pa. R. E. Blackwell, Pittsburgh Section ISA, Box 1346, Pittsburgh 30, Pa.

ASM, 11th Western Metal Exposition & Congress, Mar 16-20, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif. R. T. Bayless, 7301 Euclid Ave., Cleveland 3, Ohio.

NACE, 15th Annual Conference & 1959 Corrosion Show, Mar 16-20, Sherman Hotel, Chicago, Ill. R. W. Huff, Jr, NACE, 1061 M & M Bldg, Houston 2, Texas.

AIChE, Meeting, Mar 16-20, Chalfonte Haddon Hall, Atlantic City, N.J. F. J. Van Antwerpen, AIChE, 25 W 45 St, New York 36, N.Y.

SAS, Joint Meeting, N.Y. & Philadelphia Sections, Mar 17, Phila College of Pharmacy, Philadelphia, Pa. T. Harkins, E. I. du Pont de Nemours & Co. (Inc), Wilmington, Del.

IAS, Flight Propulsion Meeting (Classified), Mar 19-20, Hotel Carter, Cleveland, Ohio. IAS, 2 E 64 St, New York 21, N. Y.

IRE, National Convention, Mar 23-26, Coliseum and Waldorf-Astoria Hotel, New York, N.Y. E. K. Gannett, IRE, 1 E 79 St, New York 21, N.Y.

Electric Association, 5th Biennial Chicago Electrical Industry Show, Mar 24-26, Sherman Hotel, Chicago, Ill. Clif Simpson, Elec Assoc, 140 S Dearborn, Chicago 3, Ill.

Polytechnic Institute of Brooklyn, Microwave Research Institute, joint Dept of Defense Research Agencies, IRE, Mar 31–Apr 2, Auditorium, Engg Socs Bldg, 33 W 39 St, New York 18, N.Y. Prof H. J. Carlin, MRI, 55 Johnson St, Brooklyn 1, N.Y.

Overseas

8th Electrical Engineers' Exhibition, Mar 17-21, London, England.

Engineering, Marine, Welding, and Nuclear Energy Exhibition, Apr 16-30, Olympia, London, England. Apply: F. W. Bridges & Sons Ltd, Grand Bldgs, Trafalgar Square, London WC 2, England.

The Institution of Electrical Engineers

Convention on Thermonuclear Processes, Apr 29-30, London, England. W. K. Brasher, IEE, Savoy Place, London, WC 2, England.

International Convention on Transistors & Associated Semiconductor Devices, May 25-29, Earls Court, London, England. Industrial & Trade Fairs Ltd, Drury Hse, Russell St, WC 2, London, England.

4th International Congress on Electroheat, May 25-31, Stresa, Italy. M. Descarsin, Union International d'Electrothermie, 14, rue de Staël, Paris 15, France.

MAGIC BOX used in calibrating accuracy of magnetic compasses by electronically "rotating the world" around a parked plane is shown in artist's illustration. Earth's natural magnetic field, flowing past north-headed aircraft (1) causes plane's compass marker to indicate north heading on compass. Technician (2) "walls off" natural magnetic field and introduces artificial field (3) causing plane's compass marker to show it heading 45° (northeast), although plane really is pointed in original direction.

resistances necessary to change magnetic headings artificially. A meter on the console provides precise indications of errors which must be compensated to make the compass read correctly.

During the procedure, a field monitor (a simple transit modified to include a direction sensor) is used to determine the directon of the magnetic field about the aircraft and to measure any changes in the magnetic field during actual calibration of the compass.

Old Procedure Costly and Complex

In contrast to the relatively simple electronic procedure, the old manual method often required the combined efforts of three or four men, an airplane tug and a full working day. The aircraft must be rotated painstakingly about a full 360° circle while crewmen check and compensate for errors on a variety of directional headings.

The circle is called a compass rose. It is a costly, precisely surveyed compass face—100 or more feet in diameter—painted usually on a concrete surface at an airport far from buildings, electrical equipment, and other sources of magnetic disturbance.

Because of the great expense involved in constructing compass roses—some as much as $250,000—only major air bases are so equipped, making it necessary to fly aircraft long distances to have compasses checked.

The manual method also makes it extremely difficult to reduce magnetic heading errors in compasses to less than 1°. This is increasingly disturbing because a 1° heading error can put a high-speed, long-range aircraft 1 mile off course for each 60 miles flown.

The newly developed electronic method described, however, can reduce these errors to 0.1°. The only devices needed, in addition to the electrical console, are a tripod similar to that used by a surveyor and a field monitor, a simple transit modified to include a special magnetic sensing device.

Hurricane Road Simulates All Types of Weather and Road Conditions

FROM FAIRBANKS, ALASKA, to Phoenix, Ariz., in 30 minutes—by car! That is just one of the accelerated tests available to Ford Motor Company in "Hurricane Road."

Able to test cars under both climatic and road conditions the new test facility incorporates a General Electric (GE) dynamometer system which permits not only speed control, but also load correction factors for grade and windage.

The new amplidyne–electronic control and dynamometer eliminate the need for large flywheels, formerly used in such systems. According to GE engineers, the new system is far simpler to operate and provides much faster response in addition to being less expensive to install and operate.

System Design

The system was engineered and manufactured by GE working closely with Ford engineers. The control console is the largest dynamometer console manufactured in the United States to date.

Wind velocities from 0 to 125 mph are produced by the huge 24-foot, five-bladed

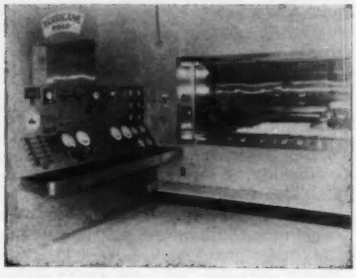
fan equipped with aircraft type propeller blades. Intermittent wind velocities as high as 140 mph can be attained.

Providing adjustable speed d-c power for the fan motor, the fan drive motor-generator set, rated at 2,000 hp, generates 1,500 kw of power. The fan drive motor is rated at 2,000 hp at 500 rpm. Motors and generator for the fan drive were built by GE Large Motor and Generator Department, Schenectady, N.Y.

The huge fan is driven by a Ward-Leonard adjustable speed drive system which not only allows varying velocities, but also is electrically interconnected with the dynamometer in order to simulate wind velocities proportional to test vehicle speed during acceleration and deceleration tests.

Testing

Temperature in the test chamber can be varied from 0 to 160 F. The 240 sun lamps, recessed in the ceiling of the tunnel directly above the test vehicle, can be switched on or off in combinations from the control console by the test director. Simulated sun load on the vehicle may be varied from 0 to 480 Btu's per hour per square foot.



DYNAMOMETER control console for Hurricane Road wind tunnel controls elemental conditions inside the Ford test facility. Variable conditions are simulated to test vehicles and components.

Cooling and heating tubes, located ahead of the tunnel's venturi section and also controlled from the operator's console, have ranges from subfreezing to near boiling temperatures. Another simulated elemental test includes rain, produced by injecting water into the tunnel airstream.

In addition to airspeed, temperature, and humidity, the test director also can control—from the master console—test vehicle speed, throttle position, fuel, windage and grade loading, and vehicle inertia. Separately controlled variables such as transmission and differential oil temperatures and engine oil and water temperatures also can be governed by the test director from the console.

All of these functions, in addition to various oil and vacuum pressures, strain indications, selected test temperatures, engine and test vehicle speeds, and torque are fully instrumented and visually displayed on the console.

Major Atomic News and Reactor Development Programs

"Tom Thumb" Neutron "Detective." Splitting atoms of uranium, placed on a sensitive semiconductor no larger than a pinhead, make up the smallest known neutron detector. Recently developed by Westinghouse atomic scientists, it is designed to probe deep inside a nuclear reactor core and map the neutron flux—the most basic piece of information needed for proper reactor design. Its tiny size permits "looking" into tight, out-of-the-way spots, such as the spaces between close-fitting core fuel plates. Presented before a meeting of the ANS by Dr. K. H. Sun, advisory physicist in the materials engineering department in Pittsburgh, Pa., the detector was said to have "potential significance comparable to conventional gas or scintillation types of detectors" now in common use. It consists of a tiny slice or silicon of germanium having a sensitive junction or layer near the top surface of the slab and is known as a semiconductor diode. It is commonly used in such devices as rectifiers and solar batteries. The detector has a deposit of uranium on it about a millionth of an ounce. Hair-thin copper wires are soldered to it and then it is sealed inside one end of a thin aluminum tube about the size of a piece of spaghetti. The detector is wired to suitable electronic amplifyng and recording apparatus and is ready to be inserted into the reactor core. Slow-speed neutrons strike this uranium surface and cause U-235 atoms to split apart thus producing "fission fragments—fast charged nuclei of atoms that burst into being as the uranium nucleus falls apart." The energized particles crash through the diode detector junction and upset its electrical balance. This results in an electrical pulse that can be detected and counted.

SMALLEST known neutron detector developed by Westinghouse scientists, exhibited against fingernail, shows its "Tom Thumb" proportions.

Samarium-153. A "potentially valuable" new radioisotope source, Samarium-153 (which emits low-energy radiation), was reported recently at the American Nuclear Society (ANS) meeting. Developed by General Motors (GM) Research Laboratories, Samarium-153 already has been used experimentally for both industrial and medical radiography and is considered "a breakthrough in the field of low-energy photon sources." The GM report said that plans are under way to make the new source available to licensed users of industrial and medical isotopes. Samarium-153 shows industrial promise in such uses as liquid-level gauging, thickness gauging, and specific gravity measurements under unique conditions. Its medical uses include special diagnostic X ray and, possibly, experimental dental X ray. However, the ANS meeting was

HURRICANE MAKER, powered by GE 2,000-hp d-c motor and electrically geared to the GE dynamometer, simulates road speed and wind velocity. This 24-foot five-bladed fan can be varied to produce winds from 0 to 120 mph in Ford Motor Company's new "Hurricane Road" test facility.

told that Samarium-153 "will not replace an industrial X-ray machine in a fixed radiographic installation." Its main use would be in plant, field, or laboratory areas where "portability" is desired to augment regular X-ray facilities.

UN Technical Assistance Newsletter. The Economic and Social Council voted to admit the newly created International Atomic Energy Agency as a participant in the Expanded Programme of Technical Assistance. The new agency motto reads, ". . . to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life." Its functions would include technical assistance to underdeveloped countries in all nuclear phases.

Remote-Control Atomic Research. A closed-circuit, remote-control television system is providing General Atomic Division of General Dynamics Corporation with an "impervious" eye located close to the business end of a high-powered linear electron accelerator. Recently installed in an underground bunker at the San Diego, Calif., research laboratory, the accelerator uses microwave radiation to speed up electrons until they are traveling at speeds close to that of light. When these hit the target under test, atomic particles and X rays scatter in all directions causing radiation levels that measure 10,000 roentgens per hour. Safe limit for humans is 0.3 roentgen per week. To focus the electron beam, however, it is necessary to "see" the pattern made by the electrons as they come out of the accelerator and hit a fluorescent screen. Operators use this pattern to adjust magnets that focus the beam into a pencil width of high-speed electrons standing behind a massive lead and concrete wall to observe operations through a dependable high-resolution television system built by the KIN TEL Division of Cohu Electronics. The television camera can withstand accelerator room radiation almost indefinitely, but the camera lens turns brown with continued exposure to soft X rays, so a sheet of window glass provides an effective inexpensive expendable shield. The same camera and monitor system is also used to observe instruments mounted in the target area, and to keep track of the equipment during test.

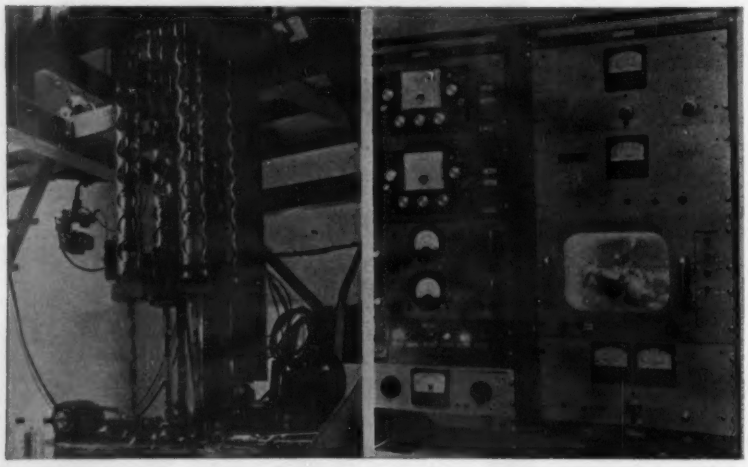
Success in Removing Plutonium from the Body. Two compounds that grasp metal atoms in octopus-like molecular tentacles ave proved effective in flushing out radioactive plutonium from the bodies of laboratory experimental animals—even when treatment is delayed for several days. Scientists from the Argonne National Laboratory, Division of Biological and Medical Research, one of a number of research groups studying these compounds, made the announcement. Their treatment, thus far, has been used successfully to remove plutonium from the bodies of rats. It was reported that a laboratory research team has had success with two metal-grasping substances known as DTPA (diethylene-traminepentaacetic acid) and BAETA (2:2′-bis [di (carboxymethyl) amino] diethyl ether) which possess an extraordinary number of tentacles, so arranged that the plutonium atom is imprisoned in a molecular cage from which escape is virtually impossible. These compounds are known as chelating agents, substances that sequester metal ions to form a stable water-soluble complex that is relatively chemically inert and naturally flushed out of the body by normal elimination processes. DTPA and BAETA are not poisonous to man.

Master–Slave Manipulators with "Feel." At the Argonne National Laboratory, the scientist has been provided with easily controllable mechanical arms as well as binocular vision which extends his view. Thus, he can operate existing standard laboratory equipment behind shielding barriers with a minimum of modification. The operator is an integral part of the system and works in an automatically natural manner–no special thought given to make each succeeding move. A total of eight mechanically controlled master–slave manipulators with extreme mobility feature a force-reflecting servomechanism which automatically controls the output (slave arm) to follow the input (master arm) and at the same time reflect the force acting on the slave back to the master. In this way, the operator gets the "feel" of the object he is handling by remote control.

Brookhaven Medical Research Center Dedicated. The newest atomic Medical Research Center in the United States, including the world's first nuclear reactor designed specifically for medical use was dedicated at Brookhaven National Laboratory, Upton, L.I., N.Y., operated by Associated Universities, Inc., for the U.S. Atomic Energy Commission. In addition to the reactor, the new Brookhaven Medical Research Center includes a 48-bed hospital for research patients and laboratories for studies on medical application of atomic energy. Unique design features of the reactor include two ports on opposite sides which permit streams of neutrons from the core to pass through the heavy concreate shielding walls into treatment rooms—one for patients and one for experimental animals. The beams can be shut off by means of thick 21-ton shutters in 3 seconds. In addition, kinds of radiations in the beams can be varied by inserting different combinations of absorber and "convertor" plates in the beam. This makes for unusual reactor flexibility. A third face is equipped for general irradiation of large objects and the fourth has "rabbit holes" leading into the core to permit irradiation of small samples of materials for diagnostic purposes and for making the short-lived radioisotopes. The availability of these isotopes at the hospital site, where they can be used before they decay, will make possible a broad range of medical investigations into fundamental body processing. Physicist-reactor operators will service the reactor under direction of staff physicians who will have patients under direct visual control at all times. It has a nominal operating power level of 1,000 kw. Ordinary water cools and moderates the new reactor which has enriched uranium fuel elements.

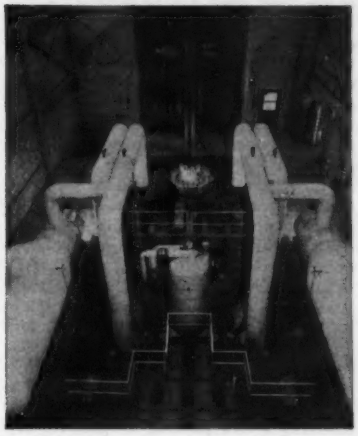
The Atom against Cancer. The role genetics plays in cancer is still obscure but radiation (even in small amounts is an effective means of causing genetic change. Medical genetics has been lagging. With the new tools at the Brookhaven Medical Research Center, it may receive a useful stimulus and the relation to cancer may be clarified by specialized work done at the Center.

SPERT-III Achieves Criticality. The Special Power Excursion Reactor Test No. 3 (SPERT-III), one of a series of reactors designed and developed by Phillips Petroleum Co. as part of the AEC's program to find basic explanations for reactor behavior under runaway conditions, has gone critical. All operations are conducted by remote control because tests approach reactor destruction. Providing the widest possible range of control over temperature, pressure, and coolant flow rate, this plant is expected to contribute significantly to a better understanding of reactor self-limiting and occasional instability characterstics. This high-pressure high-tempera-



REMOTE-CONTROL is possible by use of KIN-TEL camera (*left*) which permits observation of control rods action during critical-assembly test at General Atomic Laboratory. Camera pan-tilt controls are alongside monitor screen (*right*) in laboratory control room. Radiation levels near critical assembly are lethal during test.

TOP CAP and control mechanism of SPERT-III. Technician is manually checking out the reactor control rods. Facility is operated by Philips Petroleum Co. for the AEC.



GENERAL INTERIOR of SPERT-III. Bird's eye view shows reactor top and control rod drive mechanism *(top center)*. Small white tank *(bottom center)* is system pressurizer. Horizontal vessels on either side are heat exchangers. Operated for the AEC by Philips Petroleum Co. at the National Reactor Testing Station in Idaho, SPERT-III is the nation's most versatile facility for studying nuclear reactor safety.

ture light water moderated and cooled reactor will enable the performance of transient tests under pressures ranging from atmospheric to 2,500 psi; water temperatures from 68 F to 668 F; and coolant flow rates from 0 to 20,000 gpm, with heat removal capacities up to 60,000 kw for a duration of 30 minutes. SPERT-III is fueled with highly enriched uranium, with positions provided for 68 fuel assemblies and 8 control rods. The reactor vessel itself is capable of withstanding shock pressures up to 3,500 psi.

Household Nuclear Fallout Warning Siren. "Banshee," a new device plugs into any standard radio or television set and sounds a waiting alarm through the loudspeaker when exposed to radioactive-fallout in dangerous concentrations. The Tracerlab, Inc., Waltham, Mass., developed inexpensive and dependable unit also acts as a pathfinder to lead survivors out of radiation danger areas, when attached to portable or auto radios. The pitch of the Banshee's wail rises as the amount of radioactivity increases and diminshes as the amount of radiation decreases. The tiny device plugs into a standard radio tube socket, and then the tube, in turn, is plugged into Banshee. In a-c operated sets, it will operate as long as power is available. At 100 milliroentgens per hour, Banshee makes a popping sound. When radiation increases to 1 roentgen per hour or more, as it would with the passage of a nuclear fallout cloud, the unit emits a continuous high-pitched wail.

Atomic Waste Disposal Panel. The IAEA panel on the disposal of radioactive wastes in the sea ended its first series of meetings in Vienna after setting up working parties that will co-operate with the IAEA staff on a number of specific problems. The problem of pollution of the seas from peaceful use of atomic energy has two fundamental aspects—the first concerned with pollution by intentional and more or less controlled releases of radioactive wastes, the second with pollution that may arise from accidental entry of radioactive material into the seas. The panel report will be the basis for drafting a convention on the disposal of radioactive wastes into the seas.

Six Westinghouse Research Concepts. Use of thermoelectric materials in reactor fuel elements to convert the heat of splitting atoms directly into electricity is one of the new reactor design program features revealed recently. The primary goal is the possibility of achieving economic power from the energy in the atom, it was stated. Another disclosure was the OMFBR (organic moderated fluidized bed reactor) which uses small marble-sized fuel pellets instead of movable control rods and fuel elements in fixed position. The Yankee Atomic Electric Company light-water reactor plant, the Belgian pressurized-water reactor plant, and the homogeneous reactor jointly operated by Westinghouse and the Pennsylvania Power and Light Co. are some of the other developments. A major program to implement the installation of a significantly modified and improved type of water reactor is being carried out for the Carolinas–Virginia Reactor, which eliminates the large pressure vessel now associated with existing pressurized-water reactors.

Low-Cost Source of Electric Power for Memphis Area

Anticipating expiration of its wholesale power contract with the Tennessee Valley Authority (TVA) in June 1958, the Memphis Light, Gas & Water Division devised plans in 1955 to build its own generating stations rather than rely on other sources for its requirements. Fast-growing power needs demanded a reliable and low-cost source of abundant electric power. The publicly owned Thos. H. Allen Electric Generating Station will produce this power at the same relative rates to consumers as now prevail under the present TVA contract.

The engineering contract to proceed with selection of site, determination of size, and design and engineering for the new power plant was granted to Burns & Roe, Inc., in August 1955.

The location is adjacent to Mitchell Rd. on the south side of McKellar Lake, across from the Presidents Island industrial development, about 5 air miles southwest of the business center of Memphis. The plant is within the corporate limits of the City of Memphis.

The station has fourteen 3-phase 161-kv oil-filled circuit breakers having a 15 million kva total interrupting capacity. High voltage is achieved by three step-up transformers, primaries of which are connected to the 24-kv output of the generators. Within the main structure of the building three steam generators, having seven cyclone furnaces each, rise 200 feet above the basement level. The 3-story portion of the building houses administrative and engineering offices. The $121 million Thos. H. Allen Electric Generating Station is the largest steam-power plant ever authorized at one time by any municipality. It will supply the entire City of Memphis as well as the nearby areas of Shelby County.

The operating floor at an elevation of 240 feet is 8.6 feet above the highest re-

WOOD AND PLASTIC model reactor, used by Westinghouse scientists in atomic power department to study equipment placement and remote handling procedures for maintenance of homogeneous type reactors, shows reactor vessel at center. Connected to it are four primary loops which carry a slurry through reactor vessel where nuclear reaction takes place. From there, slurry flows to steam generators, producing steam to power turbines and generate electricity. Model scale is indicated by wooden 5-foot 10-inch "men" in foreground. Joint venture with Pennsylvania Power & Light Co. is an AEC approved reactor research and development program.

FOURTEEN circuit breakers are arranged in line in switchyard.

corded flood stage of the Mississippi River, and more than 5 feet higher than the existing levee system.

Cooling water requirements will be 550 million gallons per day (gpd) for the three initial units and 1,100 gpd should plans materialize for three additional units. The circulating water intake structure, housing the traveling screens and water pumps, is located at the edge of McKellar Lake. The dual discharge tunnel from the intake structure enters the intake tunnel between units 2 and 3. From the intake tunnel, each electric generating unit is serviced by an individual circulating water tunnel.

The building contains three Babcock & Wilcox cyclone-type steam generators with a capacity of 2.1 million pounds per hour; superheated steam temperature of 1,053 F and operating pressure of 2,475 psig. No induced draft fans are used. A combination of cyclone-type boilers and electrostatic precipitators will remove 98.4% of the original ash in the coal. After the flue gas leaves the precipitators, it will pass into the 400-foot high stack.

The steam generators are designed for firing by either coal or natural gas. Each steam generating unit is provided with automatic combustion and temperature controls. There is also an automatic water control system. An automatic sequential air puff soot-blowing system is provided for each steam generator.

Gas is to be used in the summer when the Gas Division has a surplus in excess of the residential and industrial requirements. At peak capacity, the boilers consume approximately 255 tons of coal per hour. Storage area is provided for 90 days' operation, or 9,000 carloads—approximately 450,000 tons. Coal for the generators is delivered by barge.

A digital readout and logging system on combustion controls records approximately 244 points, such as the boiler drum and superheater temperatures, bearing temperatures, etc. An automatic dispatching system is incorporated into the plant. It permits incremental economic loading, using any and all three units most effectively under prevailing conditions. Remote control of the plant is possible by the dispatcher in the service building via the microwave system which connects his office with the generating plant and primary substations around the city. The microwave has two functions, the first, voice communication and the second, signals, both of which operate the apparatus.

The three initial turbines have been installed and are operating at partial capacity with a total of 200,000 kw output. Each of these turbines is of the Westinghouse 3,600-rpm 3-cylinder tandem-compound triple exhaust type with a name plate capacity of 250,000 kw each. These machines are operated at steam conditions of 2,400 psig and 1,050 F at the turbine throttle with reheat to 1,050 F. The high-pressure turbine (first cylinder) has one 2-row impulse stage and 13 pairs of reaction blading. The intermediate-pressure turbine (middle cylinder) has 10 pairs of reaction blading. The low-pressure turbine (part of the middle cylinder) has seven pairs of reaction blading, and each half of the double low-pressure turbine (third cylinder) has seven pairs of reaction blading. The turbine–generator has eight extraction openings which are used for feedwater heating. The turbine is equipped with a hydraulic oil relay type main speed governor.

Heat rate efficiency of the turbine–generator units, running under optimum conditions, are expected to be 8,825 Btu per kwhr; at 50 per cent load factor, 9,100 Btu per kwhr. The country-wide average is 13,000.

Inner-cooled with hydrogen being circulated through both the stator and rotor windings, these three 3,600-rpm generators have the following ratings at 85% power factor.

Hydrogen Psi	*Kva*
30.0	278,261
45.0	320,000

The generators are single-wound units with an output voltage of 24,000 volts. Each generator requires 2,200 cubic feet of hydrogen for normal operation. It is expected that the aggregate net capability of the three units will be 812,500 kw.

Each generator is served by a main exciter driven at 718 rpm through a reduction gear from the main shaft. Each exciter is rated at 1,050 kw, 375 volts. The exciters are controlled by Mag-a-Stat regulators—continuous static type. A 420 cps motor–generator set provides control power for the regulators. The exciters are cooled with room air drawn through filters. One spare motor–generator unit is in reserve for the entire plant. Its rating characteristics are the same as the main exciters.

Radioactivated Hormone Traced throughout Plant System

A plant growth hormone that occurs naturally shows promise of greater crop yields for farmers. At present it is being used as a research tool at the Argonne National Laboratory.

Known as gibberellic acid, it is one of a number of compounds that affect the growth of plants. Compounds of this type were first discovered in a species of fungus in Japan. The acid—commercially available—comes to scientists in the form of a fine white powder which is usually dissolved in solution and applied to plants in spray or droplets.

Gibberellic acid is being used in several plant growth research problems by the Plant Physiology Group of Argonne's Division of Biological and Medical Research. It is said to have a number of different effects on the growth of plants. The acid can make the stems grow longer, increase the length of leaves, increase fruit yield, and act as a substitute for light or temperature in some germination and flowering processes.

In addition to furthering basic knowledge of plant mechanisms, research with the hormone opens the door to numerous future applications involving chemical control of plant growth and behavior.

Work at Argonne and other Government and private installations indicates that treatment of some crop plants with the acid makes them grow larger and increases their weight. Argonne scientists have demonstrated that hemp, tobacco, lupine, sunflower, and bean plants are responsive to the acid. In West Coast areas of the United States, grape vines treated with gibberellic acid have produced a

THREE turbine–generators are housed in the building of the Memphis (Tenn.) Thos. E. Allen Electric Generating Station. Chimneys and stacks are 400 feet tall with a 30-foot OD base for each chimney.

greater yield of fruit per cluster. In hemp, female and male flowers are developed on separate plants. In a normal population, half the plants are female and half male. However, female plants treated with the hormone also formed functional male flowers, thus altering the normal pattern of flower expression.

The quantity of the acid needed to induce changes in plants may be as little as one billionth of a gram. Applied to plant organs in drops, using a device that resembles a tiny eyedropper, those plants tested by the Laboratory distribute the acid most uniformly through their systems when applied to the stem.

Dr. N. J. Scully, senior physiologist and group leader of the Division, said animals supplied with the substance in their diets have not shown toxic responses, and it is likely that the treated plants would not be dangerous to human health. He pointed out that work with the hormone is still in its early stages, and much remains to be known about what plants do with the substance. Using the radioactive tracer technique to learn more about how a plant utilizes the acid, "tagged" atoms of gibberellic acid which emit tell-tale flashes of radioactivity detectable by sensitive monitors are traced wherever they go in the plant system. Dr. Scully said Argonne scientists were the first to develop a radioactive form of the hormone to clarify its uptake and distribution in plants.

This was done by making radioactive the fungus in which the acid is found, through introduction of sucrose labelled with radioactive carbon (carbon 14). Radiocarbon is one of the primary "atomic detectives" used by nuclear scientists in tracer studies. After labelled sucrose was introduced into the culture media, the hormone was isolated by chemical means.

The function of the Plant Physiology Group at Argonne is to investigate peacetime applications of atomic energy in such biological fields as medicine, agriculture, botany, and zoology. In order to implement their various "tracer" studies with plants, the scientists have developed several unique facilities. One is the nutriculture chamber, a "miniature greenhouse" in which plants as they grow are treated with radioactive compounds.

In addition to the chambers, Argonne plant physiologists use controlled environment rooms for growing plants under constant light and temperatures to maintain desired experimental conditions; various types of monitoring equipment to detect the presence of radioactive compounds; and laboratories in which these compounds are isolated.

First N.Y. State Privately Owned Reactor

New York State's first privately owned nuclear reactor, located at Pawling, has just gone into operation at NDA–Pawling Laboratories, a facility of Nuclear Development Corporation of America, White Plains.

The low-power reactor, known as the Pawling Research Reactor (PRR), is a prototype of a Teaching and Research Reactor (TRR) which NDA has developed for university use. PRR will be used for research, nuclear studies, and demonstration purposes. It will give NDA valuable information in the design and manufacture of more advanced reactors.

PRR is distinctive among reactors in that it has no self-contained shielding but is, instead, located in a completely shielded room in the reactor critical facility at NDA–Pawling Laboratories. Consequently, when it is not operating, personnel can enter the room and have easy access to all the reactor components. While in operation, closed circuit television is used.

The 1,200-acre site contains facilities for testing reactor cores, a radioactive materials handling laboratory, and a general experimental engineering facility. An organization of 400 scientists, engineers, and supporting personnel, NDA is one of the oldest and largest independent nuclear engineering firm in the United States.

PRR, like the training and research reactors to follow it, represents an unusual combination of utility, safety and versatility in a reactor. It utilizes heavy water for neutron moderation and plate-type uranium-aluminum alloy fuel elements of well-developed technology. The reactor is enclosed in a cylindrical aluminum tank 5 feet in diameter and 4 feet high. Surrounding the bottom and sides of the tank is a 1-foot layer of graphite blocks. This, in turn, is enclosed by a layer of hydrogeneous material (Masonite) several inches thick. The graphite layer reflects escaping neutrons back into the heavy-water moderator, while the Masonite is the equivalent of several inches of water in additional reflecting capacity. The entire reactor housing is an octagonal cylinder 9 feet in diameter and 7 feet high. The PRR is licensed by the Atomic Energy Commission (AEC) to operate at a normal power level of 5 watts, with occasional operation up to 100 watts.

The PRR core consists of 40 plate-type fuel elements of uranium-aluminum alloy construction. In all, the core contains one kilogram (2.2 pounds) of fully enriched uranium. A number of safety features, any one of which would automatically shut the reactor down in case of a power surge or other emergency, are included as follows:

1. "Fail-safe" safety rods of cadmium which serve as a neutron poison and cause instantaneous shutting down of the reactor on activation. Mounted overhead, the rods automatically fall into the reactor core in response to any of several emergency conditions in the reactor.

2. Any power surge is accompanied by a sharp rise in heat production. A small rise in the temperature of the heavy water moderator will reduce the reactivity below the critical point and thus shut the reactor down.

3. The heavy water supply can be dumped rapidly, causing the reactor to become subcritical.

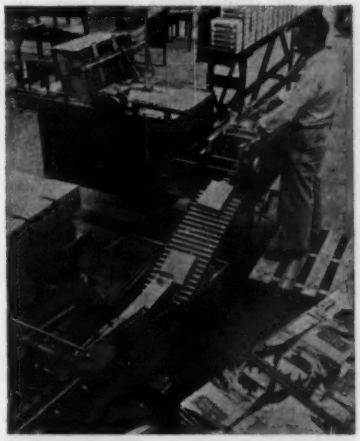
When the reactor "scrams," the control rods drop into position and the heavy water is dumped simultaneously. The water is pumped through a filter and a resin purification bed.

Another process system controls an inert cover gas which fills the voids in the heavy-water system. This prevents contamination of the heavy water by light-water vapor present in the atmosphere.

A strong industrial advocate of heavy-water reactors in this country, NDA's version of a reactor for university use is moderated by heavy water. A greater flux is possible, at any given power, through the use of heavy water. Operating at 25 kw, for example, TRR will provide a thermal neutron flux of 2×10^{13} neutrons per square centimeter per second 2 feet from the core region.

Automation and the Written Word

Today's virtual stream of new automatic machines, processes, and devices continues to have an increasing effect in the area of the world's general knowledge and its communication of that knowledge. Two recent developments, for example, deal with information processing and with information distribution. New machines to help make possible the "automatic library" of the future were demonstrated in Washington, D.C., by International Business Machines Corporation (IBM) at the International Conference on Scientific Information.



AUTOMATIC frame wrapper machine forms boxes, and packs and seals as many as 600 books an hour. Speedy packing unit operates at new worldwide distribution center of The Macmillan Company, Delran Township, N. J.

The new processes, when perfected, will provide answers to serious communication bottlenecks facing science, business, and industry. Eventually, it is believed, vast quantities of data—on subjects ranging from botany to rocketry—will be automatically read, summarized, coded, distributed, and filed by machines. As a demonstration, abstracts of scientific papers presented by participants in the conference were prepared automatically by an IBM *704* data-processing system at the company's Vanguard Computing Center. The *704* analyzed articles word by word,

selected the most significant sentences, and reproduced them on a printer.

Known as "auto-abstracting," the new process is a promising development in the area of fast and accurate information retrieval as well as a source of key words which pinpoint significant items in a document and form the basis of various automatic coding and indexing systems.

It is felt that auto-abstracts will, in many cases, become a by-product of the actual publication of technical papers, which are set in type by means of a punched paper tape containing the text. These tapes are converted to punched cards which serve as input to the computer for the auto-abstracting process. The company's researchers are presently at work on eliminating the card stage to speed the process further.

Data-processing systems can also scan through the index of a huge technical literature collection to locate all references on a certain subject. Scientists are able to receive automatically printed bibliographies complete with abstracts for each document listed.

The IBM *704*, through modern mathematical techniques, can also classify objects automatically on the basis of similarity of characteristics. In botany, for example, plants may be classified into natural groups by comparison of characteristics such as size, root structure, leaf structure, etc.

By continuous, automatic comparison of reference terms filed on punched cards, the new IBM Special Index Analyzer supplies the inquirer with a list of references which combine all the material in the library dealing with specified subjects. Reference terms for an article on the fall of the Sputnik rocket, for example, are: atmosphere, drag, orbit, rocket, and satellite.

Other applications of IBM equipment in the new field of information retrieval have included indexing and reconstruction of missing passages of the Dead Sea Scrolls, (*Electrical Engineering*, June 1958, pp. 561-62) and finding new uses for some of the three quarters of a million chemical compounds now known to exist.

In the area of information distribution, a new automated distribution center was recently opened by The Macmillan Company, one of the world's largest general book publishers. Bigger than four football fields, the center is located in Delran Township, N. J., and replaces six of the company's smaller distribution units around the country. Location was determined by the results of two surveys which considered proximity of key printers, binderies, and other suppliers, and adequate outgoing shipping facilities to customers throughout the world. Benefits expected to be gained from this consolidation include more efficient inventory control, materials handling, and storage; centralized supervision; minimum warehouse personnel; and much greater flexibility.

Between 10 and 15 million books, about four times the number contained in the New York Public Library, are to be stored in the Delran center. Nerve center of the distribution operation is a graphic pegboard panel and an inventory card system, which assure continuous inventory control. This pegboard panel is supervised by the traffic dispatcher who has fingertip control over a huge inventory of millions of different books.

Instructions for moving large numbers of books are radioed by the dispatcher directly to operators of forklift trucks scattered strategically throughout the storage area. To allow for flexibility of operation, 20% of available storage space is kept free at all times.

The main storage area is divided into three sections: a reserve section where volumes are stacked on pallets, four high; a secondary section from which larger orders are picked; and a section of bins from which smaller orders, one to ten books, are drawn. A miniature switch-controlled cable car railroad encircles the second storage area. Small "Towveyor" cars are automatically side-tracked at points where books are to be added. When an order is completed, an operator resets the control and the car moves automatically to the packing area.

For smaller orders of five books or less, volumes are collected in tote boxes from the third, or bin, section and then deposited on a maze of controlled conveyors. The conveyor system moves the books automatically to a checking area where an electronic and electromechanical traffic system prevents orders from becoming mixed or confused. After checking, orders are dispatched down an inclined gravity conveyor to packing tables. From the raised mezzanine level, checkers can overlook the packing department. By resetting the routing pin on the tote box, checkers can designate the exact packing station at which the order is to be packed.

The post office at the center is expected to handle 750,000 packages, or 60 million pounds of parcels a year. Materials handling equipment for the post office was installed by the company and leased with the property to the Government at $1 a year.

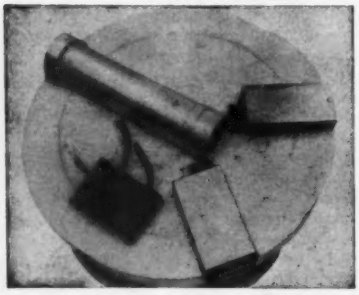
The conveyor and conveyor control system of the center was installed by the Lamson Company; the special tow line system was installed by the Jervis B. Webb Company; and Safety Industries, Inc., designed and built the wheeled carts for the tow line system.

Urethane Foam Protects Missile Instruments

Sensitive recording instruments now being carried in the nose cone of Thor and Atlas missiles sent aloft to collect vital data are being packaged in urethane foam.

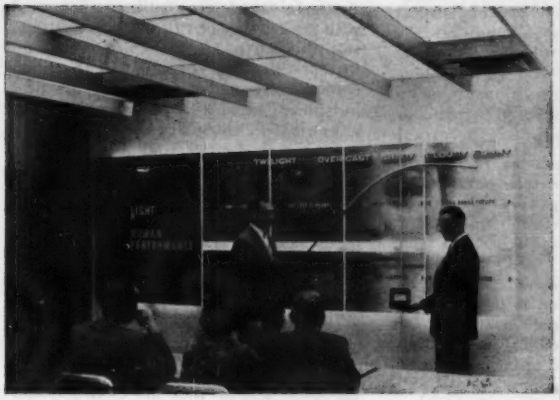
The sphere of foam, no larger than an oversized basketball, withstands impacts up to 45,000 times that caused by

A SHAFT of hard foam is being poured into hard outer shell of urethane foam to hold in place heavier parts of recording device. Smaller pieces of equipment will be encased in softer type foam. The two halves of the sphere are joined by urethane adhesive.

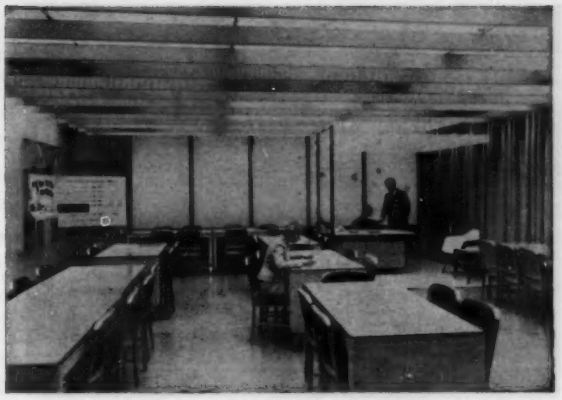


SPHERE SHOWN is complete package of delicate recording instruments carried in missiles. Besides its tremendous impact absorbing qualities, urethane foam provides buoyancy needed to keep equipment afloat for hours in water. A dense, hard urethane foam material is used for the outer shell whereas the instruments are encased in a softer foam.

HIGHLY SENSITIVE recording equipment carried in nose cone of a missile is shown being packaged in a cocoon of urethane foam. This is a segment of the foam sphere which is just a little bigger than a basketball. The shock-absorbing unit floats.



THE STORY of man's quest for light to work by is told by R. T. Dorsey (*right*), supervisor of commercial lighting applications, and W. S. Fisher, office lighting specialist, to visitors to the GE Lighting Institute at Nela Park. This display board is one feature of the Institute's new office lighting facility, which is lighted with illumination of from 500 to nearly 1,000 footcandles.



COMFORTABLE LIGHTING, 10 to 20 times brighter than the average in today's modern offices, is provided by two flexible lighting systems in the new demonstration area of GE's "best lighted office in the world." Lighting has been integrated with other comfort control systems to achieve savings in air-conditioning and heating that were not possible before this.

the force of gravity. It protects the equipment from vibration and shock from the launching to the time it is ejected and returned to earth. This cocoon of urethane foam consists of an outer shell of hard foam (20-pound density) containing a core of soft foam in which are embedded the recording devices. The softer foam (6-pound density) protects the costly, delicate equipment from vibrations and helps cushion the impact upon return to earth.

Because of the buoyancy of the urethane foam, the sphere will float for long periods of time making it possible to recover the recording equipment if it lands in water. The sphere is constructed by first molding the outer shell in halves. Then the heaviest part of the equipment is embedded in a separate shaft and the softer 6-pound foam is poured into the cavity around the other parts of the equipment.

The two halves are cemented together by the use of an adhesive derived from urethanes, and an outer covering of another material is wrapped around the package to protect it from heat while it is falling through the atmosphere. This skin splits off upon impact with the earth or water.

NOTE: The nose cones for Thor and Atlas were developed for the U.S. Air Force by the General Electric Company. The urethane foam used for this purpose is provided by Standard Plastics of Breinigsville, Pa. The foam formulation used by Standard Plastics is a product of Isocyanate Products, Inc., of Wilmington, Del. The Du Pont Company does not manufacture urethane foams, but makes "Hylene" organic isocyanates, one of the chief raw materials used in foam manufacture.

ASHAE-ASRE Merger Approved by Members

Members of the two societies have voted for the merger of the American Society of Heating and Air-Conditioning Engineers (ASHAE) and the American Society of Refrigerating Engineers (ASRE).

This announcement was made by ASHAE Pres. E. R. Queer, University Park, Pa. and ASRE Pres. Cecil Boling, West Hartford, Conn., in a joint statement following completion of balloting at a special meeting of ASHAE in Chicago, Ill., and at the ASRE semiannual meeting in New Orleans, La.

The consolidated society will be named the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

Each society recorded a high total number of ballots with 93 per cent of ASHAE and 73 per cent of ASRE voting for the merger, a grand total of 4,809 ballots having been cast.

According to Mr. Queer and Mr. Boling a two-third majority of the total vote was required to approve the merger, and this expression by the members of the two societies followed a long period of exploration, explanation, and much discussion.

Ideal Lighting for General Office Areas

As an addition to its Lighting Institute at Nela Park, Ohio, General Electric Company (GE) recently opened the "best lighted office" to the public officially.

In the new space, W. C. Brown (manager of lighting education for the GE Large Lamps Department) said, "GE engineers have created as nearly as possible the optimum total office environment which workers may some day enjoy."

The new demonstration facility introduces several important advances in lighting combined with other systems of comfort control, according to GE engineers. Most important of these are:

1. Comfortable lighting levels up to nearly 1,000 footcandles, 10 to 20 times the average illumination existing in offices today.
2. A new system of ventilating the lighting system which will virtually cut in half its load upon the air-conditioning system, and which materially can reduce heating requirements for the space.
3. A radically different new type of plastic louver designed by GE engineers which marks a major advance in creating comfortable higher level lighting systems.

Design of the environmental control system was largely the creation of the GE department's R. T. Dorsey, supervisor of commercial lighting applications, and W. S. Fisher, office lighting specialist. They worked closely with architect Wilbur Riddle of the Institute design group to integrate plans for the room with the systems which would control and stimulate its environment.

Although the room provides many times the illumination found in better-lighted offices today, lighting engineers know that the human performance of office seeing tasks is best at these levels, according to Fisher. The office contains two different and complete lighting systems. Each of these alone would outstrip most of today's modern offices in the lighting level it provides.

The biggest punch of light comes from recessed fixtures 8 feet long and 2 feet wide, each of which hold four of the new GE "power-groove" lamps which give 2½ times as much light per foot as do ordinary fluorescent tubes. This fixture has the highest generated quantity of light for its area of any recessed fixture yet, according to Fisher. Because of its high-lumen loading, none of the commonly used light-controlling materials were satisfactory.

This made necessary the development of the new louver, which is an injection-molded, vacuum-metallized "egg-crate" type. Its parabolically curved sides form a wedge-shaped louver wall. Not available commercially at present, the louver was developed experimentally by GE.

LARGE AUDIENCE views the 12- by 16-foot color picture during live Eidophor telecast. The CIBA closed-circuit unit will be used to present telecasts, live and in color, to large professional audiences in hospitals, universities, and at scientific meetings.

The new office, like other areas of the world-famous Lighting Institute, will serve a number of uses. It will demonstrate frontiers of lighting development to more than 25,000 people every year as they attend lighting conferences and general tours. Studies up to now indicate that people prefer much higher levels even for easy office tasks than they now enjoy in the best-lighted offices.

Groups of more than 50 have already used the area experimentally as a work space and for discussion sessions. These groups have found that the lighting, air-conditioning, and acoustical controls keep the room comfortable over extended periods.

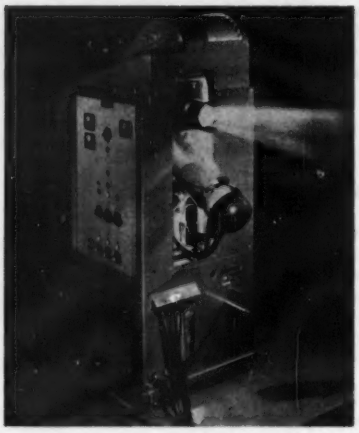
The new space will also be a laboratory. Careful study is being made of the advanced designs of environmental control systems which have been brought together there for the first time. Reports on their interrelationships and performances will be made available through technical papers of GE engineers during 1959.

Huge Color Picture Made by Television Projector

A television projector called Eidophor, which produces a large, bright, and sharp color picture, was unveiled recently at a live, closed-circuit color telecast sponsored by CIBA Pharmaceutical Products Inc., of Summit, N. J.

Eidophor, taken from the Greek word meaning "image-bearer," is a control layer projector which projects a television image on a large screen. It can produce a color picture up to 12 by 16 feet and a black and white picture up to 24 by 32 feet on a metallicized screen. Weighing about 800 pounds, the proector is 65 inches high, 25 inches wide, and 48 inches deep.

With control layer projection it is possible to achieve a contrast of 100 to 1, which is equivalent to that obtained with good film projection. Eidophor uses the field sequential system of color reproduction. Utilizing synchronized color wheels in the camera and in the projector, the field sequential system adds considerably to the accuracy of the color image produced.



LIGHT SOURCE for Eidophor projector is a 2,000-watt xenon lamp, which enables projector to be operated in any room without being subject to fire department regulations. Projector weighs only 800 pounds, is five feet high.

The control layer system of television projection was invented in 1939 in Switzerland by Dr. Fritz Fischer. After his death, work on the projector was continued by the firm of Dr. Edgar Gretener A. G., in Zurich, which had been formed with the backing of CIBA. Work was then instituted to make the device, which up to that time had been limited to monochrome projection, into a more practical instrument capable of operating in color.

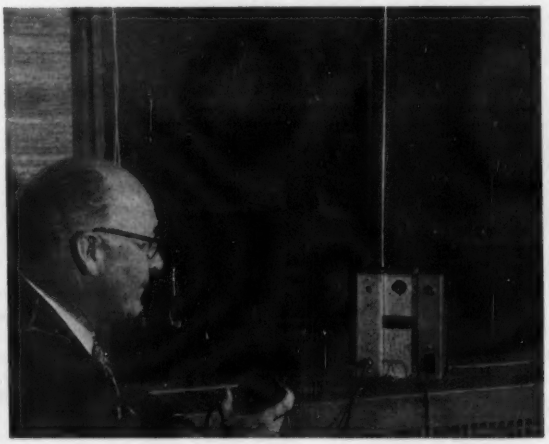
The basic elements of the control layer process are: electrical impulses from the camera control an electron beam which bombards, and thus modifies, the surface of a film of oil on a concave mirror. Light passing through the resulting "wrinkles" in the oil film is projected through a special grating onto the screen.

The control layer projection system differs fundamentally from the Schmidt system which uses a high-intensity television tube. Rather than the electronic generation of the projection light, the Eidophor system uses an electro-optical control of the light beam from an outside source to produce the picture. It is therefore, a relay system, the light output of which is limited mainly by the power of the light source (carbon arc, xenon arc, etc.).

The company has incorporated the new device into a closed-circuit television system which it is offering as an educational aid for use by scientific groups in the United States. The television cameras were made for the company by General Electric. The color television unit is completely mobile, consisting of a 35-foot-long motor trailer which houses four television cameras, two projectors, a complete public address system, two large screens and all necessary control equipment. The unit is manned by four cameramen, two video operators, one audio engineer, one projector engineer and a driver. Expected to receive heavy usage from medical and scientific groups in this country, the unit, it is hoped, will contribute to the betterment of professional and scientific communication throughout the country.

"Citizens Radio" for Two-Way Conversation

The new "Radio-Phone" was described as a "major advance in the growing field of personal communication," by President J. L. Burns of the Radio Corporation of



TWO-WAY voice transmission is possible over a distance of several miles with the new "radio-phone." RCA Pres. J. L. Burns uses new citizens radio frequency to talk with construction worker atop the framework of the new Time & Life Building across the street from his office.

Citizens Radio Frequencies

Class A*	Frequency, mc
	48 frequencies between 462.55 and 466.45 19 frequencies between 460.05 and 460.95
B	465
C	26.995 27.145 27.045 27.195 27.095 27.255
D	26.965 27.105 26.975 27.115 26.985 27.125 27.005 27.135 27.015 27.155 27.025 27.165 27.035 27.175 27.055 27.185 27.065 27.205 27.075 27.215 27.085 27.225

* Base, mobile, or fixed stations.

America (RCA). He said the Radio-Phone will be priced at about $100 a unit, and will be capable of two-way voice transmission over a distance of several miles. The new citizens radio, is expected to find wide use among small-boat enthusiasts, hunters, fishermen, and farmers, as well as in homes and automobiles. It will also be useful in railroad marshaling yards, oil fields, construction projects, and for many other person-to-person applications.

"Altogether, RCA's new-products campaign led to the development of close to 100 items, ranging in size from tiny television pickup tubes to giant radars. Of these, 57 were introduced primarily for business and industry, 31 for national defense, and 11 for the home," Mr. Burns stated.

"The wide diversity of these new products is indicative of the broadening uses of electronics—uses that now extend to virtually every phase of our daily lives. We are confident that these products will open up new markets and new opportunities, not only for RCA but also for the electronics industry as a whole."

At intervals during the year, the development of new stereophonic tape cartridge, stereo disk and tape players, transistorized "Wireless Wizard" for remote control of black-and-white and color television sets, miniature two-way radio for police and firemen, and fully transistorized general-purpose electronic data processing system for business and Government were announced.

The citizens radio is designed to operate on the citizens band frequencies recently set aside by the Federal Communications Commission (see table). On these frequencies, personal conversation is permitted, while other frequency ranges are limited strictly to business transmissions.

The new citizens radio differs from the previously announced police radio in that it is less expensive, simpler to operate, and almost anyone can obtain a license to use it.

The "Radio-Phone" weighs less than 10 pounds and measures 9 inches high, 7 inches wide, and slightly under 5 inches deep. It operates from a 6-volt or 12-volt battery, or from a standard 115-volt a-c power source.

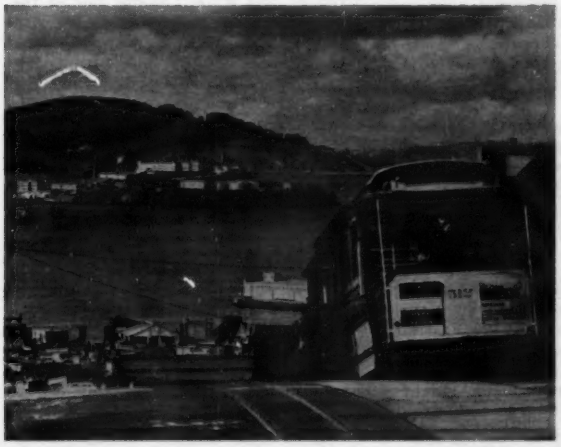
Cable Cars Powered by Electric Motor

With a tight grip on the hidden cable, the picturesque cable cars of San Francisco, Calif., are hauled smoothly up its steep hills. The power for this spectacular hill-climbing feat is supplied by a single 700-hp Fairbanks-Morse electric motor.

Today's cable car system is much the same as the original one: in the street, below and between the tracks, there is an open slot in which the cable rides on guide pulleys. To start, the gripman lowers his "grip" until it picks up the cable, 12 inches below street level. When he "feels" the cable, he lets it idle until the conductor signals a start. Then he tightens it up and off they roll at 9 mph. To stop, the gripman idles his grip, applies a wheel brake with his feet, and pushes another brake that jams hardwood blocks against the tracks, while the conductor at the other end of the car applies a similar hand brake.

From the Washington–Powell power house comes all the power to haul the 26 cable cars up the hills. Cables from the various systems come to the Powell station where they make a figure "8" over a tension carriage which takes up the slack in the lines. This slack varies from 2 to 12 feet depending, generally, on the age of the cable. When a cable is ready for replacement (every 130 days as an average) the slack is even larger. After leaving the tension carriage, the

REPAIRMAN checks the working parts of the "grip" to be installed in one of San Francisco's 26 cable cars. Cable is idled in the lower 6 inches of the grip.

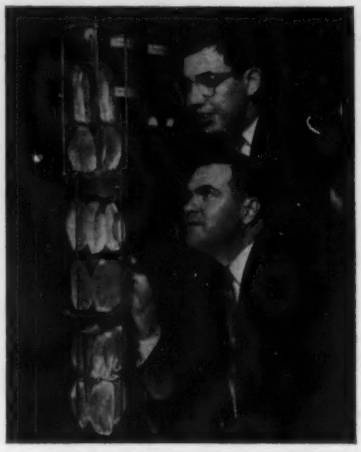


PICTURESQUE cable cars in San Francisco are all powered by a single Fairbanks-Morse electric motor. The three cables that run the system travel through a "tension carriage" and then around three power wheels. The Powell and Market Street car (above) furnishes the tourist with an awesome view of Alcatraz Federal Penitentiary.

LOOKING DOWN the cable runway from the power station gives a unique view of the incoming and outgoing cable, shown here, for the Powell Street cable car. The street line is 12 inches above the cable. The control panel for the cable car system was supplied by Cutler-Hammer.

PURE fused quartz thread which can be woven into cloth on textile equipment. From rock-like natural quartz crystals like those in the foreground, GE extracts a hair-thin monofilament, and twists these into the thread on the bobbin. Quartz cloth woven from this thread reflects its present application in the background.

FLAME TESTS, equal-thickness panels of steel, glass-reinforced plastic, and GE quartz-reinforced plastic were submitted to an oxy-hydrogen torch for 40 seconds. The flame temperature of more than 5,000 F melted and burned through both steel and glass-reinforced plastic in less than this time. Quartz-reinforced plastic withstood the flame and retained its structural strength.



SYNTHETIC QUARTZ CRYSTALS grown at Western Electric Company's Merrimac Valley works are studied by R. A. Laudise, Bell Telephone Laboratories, and R. A. Sullivan (foreground), Western Electric. Use of crystals in equipment of the Bell System will alleviate procurement problems and afford several manufacturing economies.

cables roll over power wheels and then return to their work.

All of the power wheels are on a common shaft driven by a single 700-hp motor through Western gears. Originally, a steam plant powered the cables, but after successive modernizations, in 1956 a new master power control system by I-T-E Circuit Breaker Company was installed.

The motor, gears, and controls must meet some very rigid and unusual demands. Load is extremely variable and to a large extent unpredictable. Dynamic braking by cars gripping the cable on a down-hill run help pull other cars up the hill. Unfortunately, perfect balance is a rarity. A nearly empty car gliding merrily down Powell Street does not balance a car straining up the hill with all 35 seats full and an additional 40 intrepid standees and straphangers. The electric motor back at the power house takes over the job. The system runs 20 hours a day, 7 days a week, and complete dependence is placed in this one piece of equipment.

The motor installed in February 1956 is a Fairbanks-Morse Type *QVZBK*, 700-hp, 705 full-load rpm, 3-phase, 60-cycle, 440-volt, horizontal, sleeve-bearing, wound-rotor (slip ring), induction unit. Full load amperage is 835. This heavy-duty motor has the essential characteristics of high starting torque and variable operating speed. The Cutler-Hammer controls are combination magnetic, wound-rotor, induction-starter type. The controls automatically vary motor speed and gear setting to meet power requirements. As load jumps upward, the motor is speeded up to provide more power through greater gear reduction. Cable speed remains constant.

There are seven speed points for motor operation. They must vary widely as the load requirements fluctuate tremendously. The points are: one point for continuous 1-hour operation at 40% speed; one point for continuous 1-hour operation at 50% speed; and five points for acceleration from 50% to full speed.

The new equipment already has more than 19,000 hours of service, helping the city's 26 cable cars up the precipitous slopes.

From Rocks to Rockets and Communication

Development of Quartz Thread. Gossamer-thin, continuous monofilaments of fiber, made from pure quartz, have been successfully twisted into thread and woven into cloth on textile equipment, according to the GE Lamp Glass Department, Cleveland, Ohio.

Quartz thread, in the form of cloth, may be used to reinforce plastics now widely used in aircraft and missiles, and would greatly improve strength-to-weight ratios and increase the potential payload of space vehicles, according to W. R. Becker, marketing manager of the department.

He also foresaw a wide range of possible commercial and industrial applications including such uses as filters, thin insulation in flexible or irregular form, safety devices and heat-resistant plastic structural forms for industry, machinery and building.

Key to the GE discovery is the unparalleled ability of quartz thread and cloth to withstand elevated temperatures and still retain tensile strength far in excess of any other textiles. Due to the chemical inertness of quartz it has excellent resistance to weathering. The same property limits the possibility of dyeing or staining quartz cloth. Fused quartz is exposed in industrial use to continuous temperatures over 1,800 F, and for short periods of time over 3,000 F.

As a rule of thumb, designers allow at least 500 pounds of gross missile weight for each pound of payload that the missile can lift to orbiting altitude. Thus, any significant reduction in missile weight achieved by substituting lightweight, high-strength quartz fiber means an increase in precious payload capacity.

Almost invisible, the quartz monofilaments are approximately 0.0005 inch in diameter, 1/8 the diameter of a human hair. The unique result has the basic properties of glass fabric, the very high temperature resistance of quartz, and good tensile strength at elevated temperatures.

Further properties which make quartz a material unequalled for many applications are its purity, low thermal conductivity, extremely low coefficient of expansion, high softening point, and high viscosity.

So far, all production of the quartz thread has gone into defense applications but GE is now studying several possible civilian uses.

Synthetic Quartz Production. Another success in the great "beat nature" game was announced by R. A. Sullivan of Western Electric who supervised the pilot plant activities, and R. A. Laudise, one of the Bell Telephone Laboratories scientists who brought the Laboratories hydrothermal process to the pilot-plant stage, both of whom worked to install the Western Electric synthetic quartz crystal production facility.

The Bell System, a large user of quartz for filters, oscillators, and frequency standards, has been interested in synthetic quartz processes for some time. Quartz suitable for use in communication devices comes mainly from Brazil, where its mining is carried out on an essentially free-lance basis. An apparent depletion of larger natural quartz crystals has caused critical shortages at times, vividly demonstrated during World War II when it was found necessary to develop and use other piezoelectric materials, notably ethylenediamine tartrate as a quartz substitute, for use in sonar and communication devices.

The hydrothermal process has been widely investigated on a laboratory scale for several years, and quartz crystals about 3/4 inch square by 1 1/2 inches long and larger have been grown at Bell Labora-

tories. The processing equipment has been scaled up for pilot plant investigation and quartz crystals up to two to three inches in each cross section dimension and five to six inches long have been grown in this equipment. Operations have not been directed toward growing the biggest possible crystals, but toward determining the optimum processing parameters.

Operation of the hydrothermal process depends on the maintenance of a temperature differential between the nutrient area and the seed plate area. The nutrient dissolves in the hotter lower region and is carried by convection currents to the cooler upper region. The lower temperature here leads to a supersaturated condition in the nutrient solution, which causes the dissolved quartz to redeposit onto the seed plates in single crystal form.

The combination of high temperature and pressure conditions present in this process is believed to be one of the most severe encountered in any process industry at present. This gave rise to a number of material selection and equipment design problems.

Blind Engineers Hold Technical Conference

The first technological conference in the United States at which blind engineers, technologists, and mathematicians were principal participants and discussion leaders has made some important contributions to technology and blindness, according to M. R. Barnett, executive director of the American Foundation for the Blind in New York. The 3-day conference, just adjourned, was held in New York City.

The blind technologists discussed with sighted colleagues such matters as problems of communication, tools for better job performance, mobility, braille, and reading machines.

The blind members of the group represented key organizations including the Burroughs Calculating Machine Corporation, Radio Corporation of America, the University of Detroit, the Applied Research Department of the Department of the Navy, U. S. Naval Avionics Facility, the N. Y. Institute for the Education of the Blind, C. W. Shilling Auditory Research Center, the Arma Research Foundation, the National Research Council of Canada, and the American Foundation for the Blind.

In summarizing the discussions of the unique conference, a spokesman for the group pointed out that opportunities in technology would be improved by:

1. Sharing technological know-how independently achieved by blind and sighted technologists with creative imagination in both governmental and business organizations sponsoring research.
2. Emphasizing human engineering, especially the exploration of auditory information available to blind people as they travel.
3. Adapting existing equipment for use by blind technicians, rather than redesigning especially for the use of the blind person.
4. Giving equal opportunity to the sightless person. Blind technologists have proved that they can compete successfully in industry and governmental research on an equal footing with their sighted colleagues.

In discussing the importance of human engineering the summary states:

"Little is known about the auditory information available to blind people as they travel or how it is utilized. In a development of machines, the research technologists are not aware of most of the factors involved in associating a machine with a human being."

The group of blind technologists, each of whom was invited to attend the conference because he is a success in his field, emphasized that the meeting demonstrated the ability of blind scientists to perform a wide variety of simple and complex functions in real-life situations and technological jobs, using instruments ranging from engineering slide rules to electronic analyzers.

Elaborating on the lack of communication between themselves and governmental and private organizations, the blind scientists pointed out that there is further lack of communication between these two groups and the counseling or placement service. Much improvement is needed to make it easier for those organizations who have vacancies to contact blind scientists, and for blind people to find out about vacancies they might be able to fill.

The conference was planned by the Division of Technological Services of which John W. Breuel is director. Chairman of the meetings was C. G. Ritter, consultant on aids and appliances, of the same division.

Wear Your ◆ AIEE Badge

Nozzle for Nuclear Rocket Kiwi-A

The nozzle for Kiwi-A—the first reactor designed to study the feasibility of nuclear rocket propulsions—has been delivered to the Atomic Energy Commission's (AEC) Nevada Test Site by Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif.

The nozzle was consigned to the Los Alamos Scientific Laboratory, which 3½ years ago was assigned the responsibility for investigating and demonstrating the feasibility of nuclear rocket propulsion (Project Rover). The new nozzle is now an integral part of the Kiwi-A test device. Test firing with conventional propellants was conducted at the company's Propulsion Field Laboratory in Santa Susana, Calif., before shipment to the Los Alamos Scientific Laboratory, which is operated by the University of California for the AEC.

Foremost problem overcome in the project, says Dr. S. V. Gunn, Rocketdyne program manager on the Kiwi-A nozzle assignment, was design difficulties posed by complex heat loading.

In concept, nuclear engines will use fission energy to convert working fluids into ultrahigh-temperature gases. Because the gases are heated by nuclear energy rather than by oxidation—burning—of chemical fuel, the molecular weight of the exhaust gases is not limited by the presence of the relatively heavy products of normal combustion, and higher exhaust velocities, and thus thrusts, become potentially available.

Other advantages of nuclear propulsion, Los Alamos staff members state, are a relatively inexhaustible source of energy and larger payloads. All are desirable for vehicles designed to escape from the earth's gravity field and travel in interstellar space.

Information from Kiwi-A, which is a test reactor only, will be used to design more advanced test reactors.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten double-spaced, not carbon copies. Any illustration should be submitted in duplicate, one copy a inked drawing without lettering, the other lettered Captions should be supplied for all illustrations.

Wiring Systems Evaluation

To the Editor:

I have read with great interest Mr. Steedley's excellent paper, "Evaluation of Wiring Systems for the Pulp and Paper Industry," and feel that his analysis of the three methods and the cost and test data presented are a valuable contribution to an important and much-neglected subject: the safe, economical, and reliable delivery of power and control signals to motors and control devices.

I believe that in Canada, the first large-scale use of flexible armored cables in pulp and paper mills took place in 1950 at the mill of the Richmond Pulp & Paper Co. of Canada Ltd., Bromptonville, Que.

The use of jute fillers we have long abandoned in favor of rubber fillers, in the knowledge of failures as a result of the jute taking in moisture and corrosive solutions. While better terminating methods are now available to exclude moisture, it is felt that jute or any other moisture

absorptive material should not be present within a cable.

Reference is made to the use of cable clamps for fastening cables in racks. For horizontal runs, these have been found unnecessary. During installation, light wire ties are sometimes used to hold cables while others are being installed adjacent, but these are generally removed. For vertical runs, however, cables are clamped to ladders at intervals.

The rating of neoprene as "only good" in its resistance to chemical attack does not equal its performance over a period of 7 to 8 years in the pulp and paper and mining industries in Canada. Examples of neoprene deterioration are almost nonexistent to date. Very recently, a fairly thorough survey revealed only one case of affected neoprene jacket, and this was not of a severe nature. Many examples of complete deterioration of rigid steel conduits in a much shorter time are available.

Regarding the physical strength of neoprene jackets, from large installations of armored cables with neoprene as the overarmor jacket, in 5 pulp and paper mills and about 20 mine concentrators, not one example of torn or broken jackets has been reported. Conditions of installation may be described as most severe in many cases.

While the fire and crush tests do indicate greater resistance to destruction on the part of cables in conduit, I feel that the results of these tests cannot be directly translated into performance ratings. In our experience, major damage to conduit installations has not resulted from the external application of fire as in the tests, but rather from the internal growth of fire or its communication within conduit systems from external sources. This generally results from the discontinuity of conduit systems necessitated by pullboxes and junctions, and the fact that the empty space within conduits allows the free passage of air and so propagates fire to the farthest extremities of conduit systems, consuming cable insulation as it goes. This I have actually witnessed on more than one occasion.

The greater crushing resistance of conduit installations is an advantage, but careful design of armored cable installations can reasonably assure against such severe mechanical damage. In all of the known installations, not a single case of severe mechanical damage to an important cable has been reported.

The air space within conduits is detrimental beyond the feature of fire propagation, in that it permits the "breathing" of systems and the drawing-in of moisture or vapor-laden air. Flooding and cascading water or solutions frequently gain entry to conduit systems with disastrous results.

The cost comparisons shown are comparable to those obtained by us in Canada. Early it was found that only cable trays were available for carrying the armored cables and in view first of their extremely high cost, second of their relatively light gage metal, and third of the knowledge that the cables need only be supported at intervals, it was decided to use so-called "ladder racks" and other types of racks or supports, fabricated simply from standard structural sections. These were adopted as standards and on larger projects have been generally field fabricated at low cost. In addition, as the demand increased, a number of small steel fabricating shops organized to produce these racks most economically. A small degree of field improvisation provides simple turns or sweeps, eliminating the extremely high-cost "fittings" developed by cable tray manufacturers. In layout of these racks, the amount of detailing required is negligible compared to that for an equivalent tray installation. Methods have also been developed for using the "natural" troughs provided by structural members of buildings and equipment supports with resulting economies.

It is our experience that the flexible-armored cable methods are superior to the rigid conduit method for power distribution and control circuits in pulp and paper mills, from the viewpoint of installation and uninterrupted service. Installed cost may be somewhat higher, but in view of ever-increasing labor rates, even this is now questionable. Generally, in Canada, the installation of rigid conduit must be done by fully qualified electricians at high rates, whereas, recently, on a number of our projects, relatively low-cost labor has been used to erect cable racks and to lay cables on them. It is also felt that the relatively very small extra capital investment required for fully jacketed armored cables is well made toward the assuring of trouble-free operation and that this is very soon recovered in a substantial reduction in maintenance costs.

WALTER DOW (AM '38-M '53)

(Walter Dow and Company Ltd., Toronto, Ontario, Canada.)

Loop Currents

To the Editor:

The following paragraphs, "On Loop Currents," are submitted by way of amplification of a splendid article by Kendall L. Su entitled "Component Current Method in Circuit Analysis" published in the October 1958 issue of *Electrical Engineering* (Vol. 77, pp. 947-50) under "Electrical Engineering Education."

On Loop Currents

In his special article (Component Current Method in Circuit Analysis) Kendall L. Su makes very clear the criteria for a soluble set of equations describing the behavior of linear networks. The relationship among the solutions in terms of mesh, loop, and component currents is most illuminating. In the case of the flat network used as the first example, the ingenious but uninitiated may lead himself astray when following the second of the schemes stated there (but in violation of a more fundamental consideration) for choosing loop currents.

Consider the loop currents shown in Fig. 1, which are chosen, to quote Mr. Su, "in such a way that, as each loop current path is traced, it includes at least one new branch that has not been traced before."

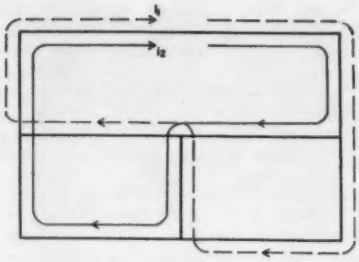


Fig. 1. Loop currents.

Although this set of loop currents obviously involves an inadequate number of independent unknowns (here the number of branches minus one less than the number of nodes clearly equals three), nonetheless, an apparently valid solution may result from going through the usual motions. There appear none of the obvious signs of implausibility—imaginary values of current magnitude, impossible zero or infinite values, or the like.

Careful consideration of the implications of the assumed currents in the faulty solution shows that, in addition to some statements about voltage drops around certain closed paths, two inadvertant constraints (which have no physical basis in fact) have been included: that currents through the lower-left and middle-right branches are equal (both are i_1), and that currents through the lower-right and middle-left branches are equal (both are i_2). These conditions are not generally fulfilled. Obviously, in any specific case in which the circuit itself imposes these constraints, the faulty solution will give the "right" answers.

Very truly yours,

C. R. WISCHMEYER
(AM '40, M '44, F '51)

(Master of Baker College and Associate Professor of Electrical Engineering, The Rice Institute, Houston, Texas)

CORRECTION—In the January 1959 *Electrical Engineering*, p. 31, the third and fourth paragraphs under "Industrial Power Rectifiers" should read as follows:

"A 7,000-ampere 500-volt d-c unit was assembled as a research project. The entire equipment is outdoors and, because of special conditions, it is direct cooled by forced air. Air enters through special louvers and filters in the doors of the rectifier compartment directly in front of the silicon-cell assemblies and is discharged through a power roof ventilator.

"The air is drawn at high velocity through cooling fins attached to the bus bars on which the cells are mounted. Cell mountings, bus arrangements, and balancing iron are very similar to the standard water-cooled rectifier."

We regret any misunderstandings which may have resulted from the fact that the first sentence of the first paragraph quoted above was inadvertently omitted.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question

ACOUSTICS, NOISE AND BUILDINGS. By P. H. Parkin and H. R. Humphreys. Frederick A. Praeger, Inc., 15 W. 47th St., New York 36, N.Y., 1958, 331 pages, 6 by 10 inches, bound. $15. A guidebook to the technical problems of acoustics from the standpoint of both the engineer and the architect, it discusses the behavior of sound in rooms; the design of rooms for speech and for music; the design of radio and television studios; the design of high-quality speech-reinforcement systems; sound insulation and noise control, including criteria and practice; and sound measurement and calculation.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS. 1957 Supplement. Published as Special Technical Publication No. 56-L. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., ous pagings, 4¼ by 7 inches, bound. $8.50. This supplement covers papers published from October 1956 through October 1957, and brings the total number of references in this series of bibliographies to over 2,600. Corrections and additions for the period 1934-55 are also included.

CLASSIFICATION AND INDEXING IN SCIENCE. By B. C. Vickery. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1958. 185 pages, 5¾ by 8¼ inches, bound. $5.50. This book explores modern techniques of subject analysis. It discusses in detail methods of constructing classification schedules for indexing, in particular the method of "facet analysis"—the grouping of terms into conceptual categories which are then subdivided generically. It describes notation for the classified catalog, gives examples of classification schemes, and discusses applications to machine literature searching.

ELEMENTARY MATRIX ALGEBRA. By F. E. Hohn. The Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1958. 305 pages, 6½ by 9¾ inches, bound. $10. The fundamental ideas and methods of the field of matrix algebra are presented. Of particular interest to engineers is the full treatment of the basic properties of determinants. In addition, there is a discussion of the Laplace expansion and the adjoint matrix used in electrical engineering. Other aspects covered are the universe of a matrix; rank and equivalence; vector spaces and linear transformations; unitary and orthogonal tranformations; the characteristic equations of a matrix; and bilinear, quadratic, and hermitian forms.

FUNDAMENTALS OF DIGITAL COMPUTERS. By Matthew Mandl. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1958. 297 pages, 6¼ by 9¼ inches, bound. $9.00. Following a discussion of fundamentals, the author explains computer arithmetic applications, binary counting, and special codes; computer circuitry, including the various gates and the circuitry utilizing them; various storage systems found in modern computers; computer programming, including specific examples of programming applied to commercial units; and comprehensive descriptions of representative commercial computers. A concluding section deals with servicing and maintenance factors.

A HISTORY OF TECHNOLOGY. Volume V. The Late Nineteenth Century, c. 1850—c. 1900. Edited by Charles Singer and others. Oxford University Press, 417 Fifth Ave., New York 16, N.Y., 1958. 888 pages, 8 by 10½ inches, bound. $26.90. The importance of applied science and its effect on manufacture and production in the latter half of the 19th Century is the outstanding theme of this concluding volume of the series. Also considered is the social effect of scientific industry upon the lives of individuals. Topics presented include primary production, prime movers, the chemical industry, transport, civil engineering, and manufacture.

JUNCTION TRANSISTOR ELECTRONICS. By R. B. Hurley. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 473 pages, 6 by 9¼ inches, bound. $12.50. The book attempts to provide engineers with a co-ordinated source of information about the characteristics and circuit applications of transistors. The first half of the book deals with low frequency linear applications and with background device physics and characteristics. The remainder of the book covers more general network analysis techniques, a greater variety of circuit applications, more complicated broadband and high-frequency circuits, and nonlinear switching applications. Useful tables of transistor circuit formulas and a substantial number of numerical examples are included.

MODERN SAFETY PRACTICES. By Russell DeReamer. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 357 pages, 6 by 9¼ inches, bound. $7. The need for designing safety programs to conform to modern management practices and newly developed and tested concepts of safety organization and administration are stressed. The safety program is presented in four phases: the development of safe working conditions, job hazard analysis and personalized safety training, promotion of employee safety participation, and enforcement of safety rules. Among other features, the book outlines consultative methods for safety.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W 39 St., New York 18, N. Y.

NOMOGRAPHY. By L. I. Epstein. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1958. 134 pages, 6¼ by 9¼ inches, bound. $4.50. The book discusses the methods of constructing nomograms and gives a thorough presentation of the underlying theory. Except for two chapters, only a knowledge of analytical geometry is required. Topics covered include determinants, projective transformations, matrix multiplication, more than three variables, empirical nomography, Kellogg's method, and nonprojective transformations.

NONLINEAR PROBLEMS IN RANDOM THEORY. By Norbert Wiener. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 131 pages, 6¼ by 9¼ inches, bound. $4.50. In this first comprehensive study of the application of random theory to nonlinear processes, a top-ranking mathematical analyst examines the role of nonlinear processes in physics, mathematics, electrical engineering, physiology, and communication theory. He demonstrates how random processes—in space as well as in time—enter into the study of statistical mechanisms, providing a useful approach to new research in, for instance, gas and plasma theory.

NUCLEAR ENGINEERING HANDBOOK. Edited by Harold Etherington. McGraw-Hill Book Company, Inc., 330 W. 42nd St. New York 36, N.Y., 1958. Various pagings, 6¼ by 9¼ inches, bound. $25. This comprehensive survey of nuclear theory and of nuclear engineering principles and techniques includes nuclear data, nuclear physics, experimental techniques, reactor physics, radiation and radiological protection, control of reactors, fluid and heat flow, reactor materials, chemistry and chemical engineering, nuclear power plant selection, mechanical design and operation of reactors, and isotopes. The material is presented on a practical level for engineers interested in the industrial uses of nuclear energy.

THE NUCLEAR HANDBOOK. Edited by O. R. Frisch. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. Various pagings, 4¾ by 7 inches, bound. $8.50. Containing condensed and tabulated data needed in research and practical applications of nuclear science, the handbook includes material on particle accelerators, charged particles, X rays and gamma rays, neutrons, fission product and transuranic elements, reactors, ion chambers and counters, deflection techniques and magnetic materials, cloud and bubble chambers, nuclear emulsions, and nuclear reactions.

NUCLEAR REACTORS FOR POWER GENERATION. Edited by E. O. Taylor. Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y., 1958. 144 pages, 5½ by 8½ inches, bound. $7.50. The book is intended for engineers who are closely associated with the building and operation of nuclear power plants without necessarily being responsible for their design. An introductory section on world energy requirements in relation to nuclear energy programs is followed by sections on nuclear physics, types of reactors, materials, the physical basis of reactor design, safety and instrumentation, and applications and economics.

THE PERFORMANCE AND DESIGN OF A.C. COMMUTATOR MOTORS. By E. O. Taylor. Sir Isaac Pitman & Sons, Ltd., London, England, 1958. 350 pages, 5¾ by 9 inches, bound. 45s. The first part of the volume covers information common to all types of commutator motors. The remaining parts deal with individual types such as auxiliary machines for the induction motor; 3-phase commutator motors; and single-phase motors, including the single-phase induction motor. In each case, the general principle and construction is first outlined and then followed by a discussion of the vector diagram and current locus as well as a treatment of the equivalent circuit.

PRINCIPLES OF QUANTUM ELECTRODYNAMICS. By W. E. Thirring. Translated by J. Bernstein. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1958. 234 pages, 6 by 9¼ inches, bound. $8. Emphasizing the physical basis of the theory of quantum electrodynamics rather than purely mathematical details, the book represents a compendium of the results which have been obtained to date. Following a discussion of the orders of magnitude of the various effects, the book examines free fields, fields with external sources, and interacting fields. Problems with solutions are given for each part of the book.

PUNCHED CARDS: THEIR APPLICATIONS TO SCIENCE AND INDUSTRY. Edited by R. S. Casey and others. Second edition. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., 1958. 697 pages, 6¼ by 9¼ inches, bound. $15. Beginning with an introduction to the use of a simple punched-card file, the book continues with case histories of punched-card applications including the Peek-a-Boo system, the Uniterm system, mechanized coding and searching techniques applied to the metallurgical literature, the Zato-coding system, and the use of punched cards in linguistic analysis as applied to ancient texts such as the Dead Sea Scrolls. This is followed by fundamental considerations in coding and systems design, future possibilities, and an annotated bibliography on the uses of punched cards.

SAMPLED-DATA CONTROL SYSTEMS. By E. I. Jury. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 453 pages, 6 by 9¼ inches, bound. $16. The basic theory of sampled-data control systems in particular and circuits, networks, computers, and system engineering in general are discussed. A general approach is provided to mixed digital–analog linear systems along with

a thorough discussion of the z-transform method which can be applied to a wide variety of fields. Problems arising in feedback control systems are solved and discussed by means of application of digital computers. General applications of the z-transform method and the operational solution of linear difference equations are enumerated and clarified.

TOPICS IN ELECTROMAGNETIC THEORY. By D. A. Watkins. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N.Y., 1958. 118 pages, 6⅓ by 9⅓ inches, bound. $6.50. A unified treatment of topics in the field of electromagnetic theory and microwave electron tubes is presented. The first chapter is devoted to periodic transmission systems and lays the groundwork for the following chapters which deal with propagation on a wire helix, concepts concerning coupling of modes of propagation, and anisotropic media with particular reference to the ferrite.

VISTAS IN ASTRONAUTICS. (First Annual U.S. Air Force, Office of Scientific Research, Astronautics Symposium). Edited by Morton Alperin and others. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1958 330 pages, 7½ by 10 inches, bound. $15. The 40 papers included in the symposium report are presented under 6 major headings: (1) reentry problems of satellite vehicles, both dynamic and thermodynamic; (2) tracking and communications for satellites and other space vehicles; (3) environment and measurements, radiations in the high atmosphere; (4) propulsion of space vehicles, including the plasma jet; (5) orbit study and control; and (6) human factors in connection with space flight.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

COMPANY CLIMATE AND CREATIVITY. More than a hundred authorities on the subject of creativity have contributed their ideas and opinions to this study which explores the impact of the business and industrial environment upon the creativeness of the technical men who must work within it. Among these experts, who are members of industrial firms, universities, and consulting organizations, there was almost unanimous agreement that it is top management which is primarily responsible for setting the climate for creativity within the company. The book is in seven sections, including: The Creative Context: Culture and Industry; Top Management's Role in Creativity; Barriers to Creative Climate; Degrees of Structure and Control in Creative Research; Physical Arrangements for Creativity; Motivating the Creative Man; and Profile of the "Ideal" Supervisor for Creative Groups. A bibliography is included. Prepared by Deutsch and Shea, Inc., technical manpower consultants, the book is published by Industrial Relations News, 230 W. 41st St., New York 36, N.Y., and is available at $10.

PROCEEDINGS OF THE ROYAL INSTITUTION OF GREAT BRITAIN. Now published three times a year instead of annually, The Proceedings contain authoritative accounts of research and learning, written for the nonspecialist and covering many branches of science and other subjects, enabling the reader to get a broad survey of the most important advances in a wide field. Included in the Proceedings are accounts of the Institution's Friday Evening Discourses, given by leading scientists. Subscription rate is 21 shillings a year; individual copies are available at 8s 6d each. Orders should be sent to The Royal Institution, 21 Albermarle St., London, W 1, England.

MAINTENANCE HINTS. A 650-page revised edition of this handbook has been published by Westinghouse Electric Corporation. Designed to provide a quick, complete, and convenient guide to modern maintenance practices on all types of electrical equipment, the handbook is divided into two sections. The first 17 chapters cover specific apparatus maintenance; the last 7 cover general maintenance of materials used in apparatus, such as insulation. The new edition contains a chapter on maintenance of static controls; the chapters on electronics and electric brakes have been considerably altered and enlarged. Copies may be ordered from Westinghouse Electric Corporation, P.O. Box 2099, Pittsburgh 30, Pa., at $2.00 each.

HEAT GAIN CALCULATOR. A useful tool for architects and engineers who determine air-conditioning loads, the calculator is on the slide rule principle. Developed by the research department of Libbey-Owens-Ford Glass Company, the calculator has two separate scales: one produces the heat-gain values at certain latitudes, for certain dates and hours of the day, and six different types of window glazing; the other provides the factors for convected and conducted heat gain caused by the difference between outside and inside temperatures. Heat-gain values in the calculator are based largely on material published by the American Society of Heating and Air-Conditioning Engineers in the ASHAE Guide and Research Reports. Copies of the calculator are obtainable from Libbey-Owens-Ford Glass Company, 608 Madison Ave., Toledo 3, Ohio, at 50¢ each.

PROCEEDINGS OF A CONFERENCE ON RESEARCH AND DEVELOPMENT AND ITS IMPACT ON THE ECONOMY. This report of a conference held during May 1958 in Washington, D. C., has been made available by the National Science Foundation, and may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $1.25 a copy.

ENGINEERING MANUAL: A Practical Reference of Data and Methods in Architectural, Chemical, Civil, Electrical, Mechanical, and Nuclear Engineering. Edited by J. H. Perry and R. H. Perry, this manual gives engineers a concise reference to the most commonly used data and methods in these six areas of engineering. Mathematics, mathematical tables, and physical and chemical data essential to all engineering are provided in three separate sections prefacing the manual. Specialized tables, graphs, charts, formulas, and other practical aids are presented within the appropriate engineering sections. The 680-page book is priced at $9.50. Further details on the manual are available through McGraw-Hill's Industrial and Business Book Information Service, 327 W. 41st St., New York 36, N.Y.

IEC PUBLICATION 105. This publication, "Recommendations for an International Specification for Commercial Purity Aluminum Busbar Material," was recently made available from the American Standards Association (ASA). Prescribing the electrical properties of commercially pure aluminum for busbars, regardless of the cross-sectional shape of the bus, it thus provides a basic international standard of resistance for aluminum busbar material, comparable to the international standards of resistance for copper established in 1925. IEC Publication 105 was developed by Technical Committee 7—Aluminum—of the International Electrotechnical Commission (IEC). Copies are available at 60¢ from ASA, Dept. PR 36, 70 E. 45th St., New York 17, N.Y.

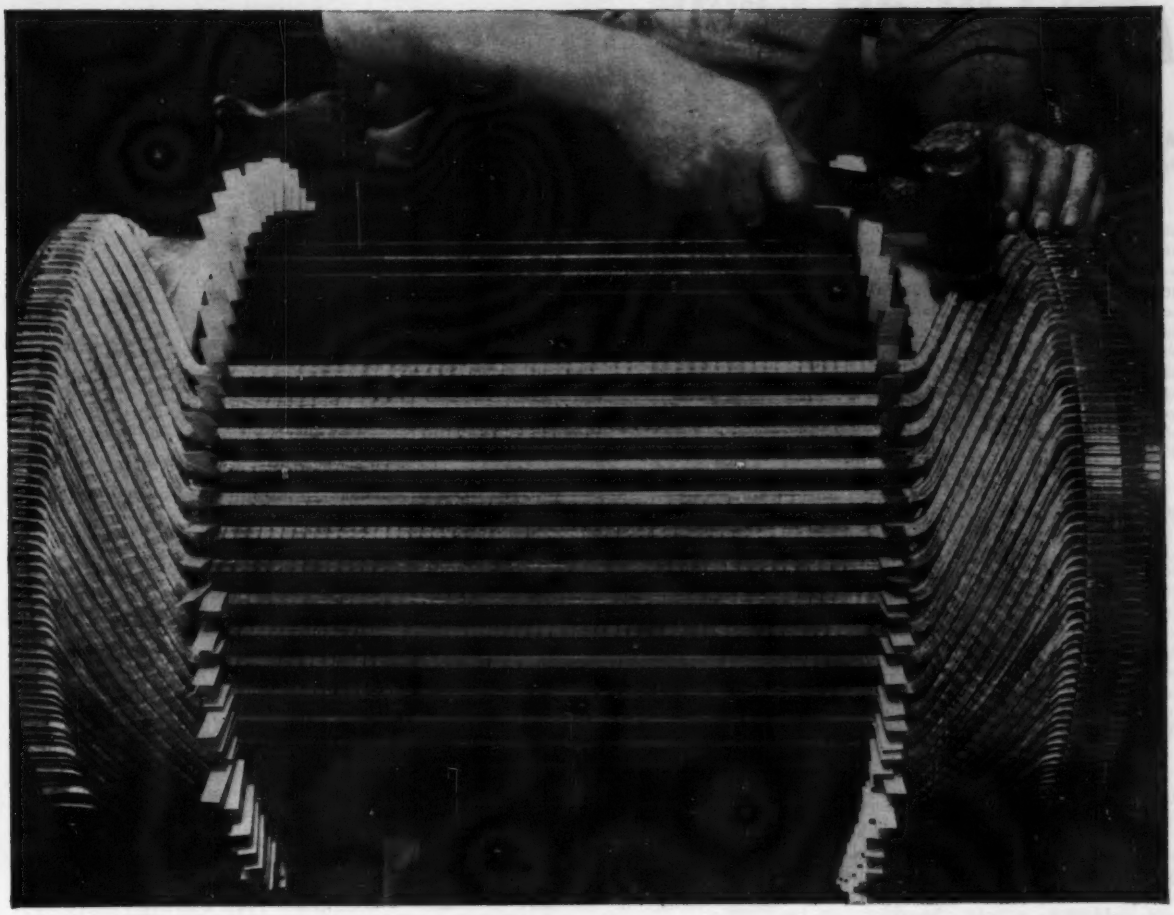
SYSTEM PLANNING OF REACTIVE SUPPLY. This publication, No. 58-9, is a report of the System Planning Subcommittee of the Electrical System & Equipment Committee, Edison Electric Institute (EEI). In order to provide a guide to the planning of reactive supply for electric utilities, consideration is given to the comparative merits of various sources and locations of such supply, to the effects of location and control on voltage levels and regulation, and to the principal operating limits involved. The pamphlet is available to members and their employees at 50¢, to nonmembers in the U. S. at $1.25, and to foreign countries at $1.35, from EEI, 750 Third Ave., New York 17, N.Y.

STUDIES IN HUMAN ENGINEERING. Four reports of human engineering research for the U. S. Armed Forces, including an extensive bibliography of the literature in the field, have been released for the use of industry and psychology researchers. (1) "Human Factors Considerations in the Design Proposals for a Ballistic Missile Unit Proficiency System," *PB 131696*, 50¢ provides an outline of steps in the design of a "Unit Proficiency System" for a ballistic missile program. (2) A general survey of what is known about man's ability to make use of his sensory capacities for gathering information is presented in *PB 151160*, "Man's Senses as Informational Channels," $2. (3) *PB 151189*, "Aircrew Fatigue Problems during Extended Endurance Flight: Phase 1—Planning," $2.25, outlines a plan for an experimental program designed to determine the effects of confinement stresses of a five-man crew. (4) "Human Engineering Bibliography, 1955-56," *PB 131507*, $4.75, is one of a planned series of bibliographies of literature concerning human engineering. All four reports may be ordered from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

11TH SURVEY OF ELECTRIC POWER EQUIPMENT. The report, EL (58)5, combines the results of two studies carried out by the Organization for European Economic Co-operation (OEEC) concerning equipment used in the electricity supply industry. These two complementary surveys, which show the situation as of January 1, 1958, and give an indication of probable trends up to 1961, thus contain information which is assumed to facilitate the electricity supply industry and producers of equipment in the drawing up of their development and production programs. Copies of the study may be ordered from OEEC Publications Office, 1346 Connecticut Ave., NW, Washington 6, D. C., at $2 per copy.

AEC INFORMATION recently released, which is of interest to the general public, can be obtained from the U.S. Atomic Energy Commission, Washington, D.C.

Number	*Title*
A-315	AEC Seeks Expressions of Industrial Interest in Co-operative Establishment of Gamma Irradiator
A-317	United States Presents $350,000 Check to Spain for Completed Reactor Project
A-318	Shute Appointed Manager of AEC's San Francisco Operations Office
A-319	Maj. Gen. A. R. Luedecke Begins Work as AEC General Manager; P. F. Foster Becomes Deputy General Manager
A-320	AEC Sets Base Charges for U-233 and Plutonium Made Available for Research and Development Uses.
A-321	AEC Enters into Negotiations with Combustion Engineering for Operation of ALPR
A-323	AEC Proposes To License Houston Firm To Dispose of Low-Level Radioactive Wastes in Gulf of Mexico
A-324	U.S. and Belgium To Sign Contract for Sale of Uranium for Use by Belgian Congo
A-325	Municipal Group To Assemble Information for AEC on Impact of Atomic Energy on Local Governments
A-327	AEC Authorizes Contract Negotiations on Studies of Three New Reactor Concepts
A-322	AEC Selects Proposals for Studies of Three Reactor Concepts
A-326	Air Force Selects Site for Installation of Factory-Assembled Nuclear Power Plant
A-330	AEC Receives Eight Proposals for Oxide Fuel Cycle Development Program
A-331	AEC Establishes Reactor Supervisor Training Program at Shippingport Atomic Power Station
A-332	AEC Proposes To Issue Operating License for University of Oklahoma Teaching Reactor
A-333	AEC Issues Order and Initial Decision in PRDC Matter
A-334	Brookhaven Medical Research Center Dedicated December 16



NEW NECCOBOND* ARMATURE COIL

adds life to traction motors...cuts rewind time

NECCOBOND is National Electric Coil's name for a new and improved insulation system developed in its own laboratories. Neccobond has been applied to traction armature coils offering these advantages:

Cooler operation, due to rapid heat transfer from void-free insulation.

Greater wear-resistance, due to high mechanical strength.

Excellent moisture resistance, because of complete encapsulation.

Easier, faster winding, due to a high degree of uniformity.

Call in your nearby National Electric Coil field engineer for complete information, then order a trial quantity of Neccobond armature coils. Prove to your own satisfaction that these coils add life to your traction motors... cut rewind time... save money!

***Neccobond** armature coils are insulated with mica and glass, pre-impregnated with a catalytic-type, high temperature resin. Controlled curing then produces an insulating wall with markedly improved characteristics.

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New and Improved Products . . .

Aluminum Transformer Housings . . .

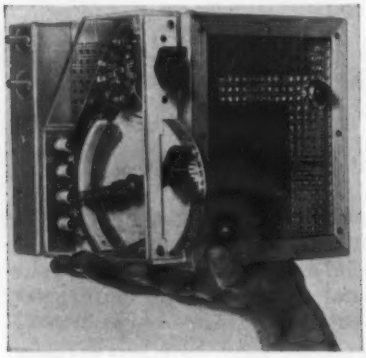
Weighing less than one third of its steel equivalent, aluminum distribution transformer housings are expected to develop into a 25 million pound a year potential market. Produced from extruded sections with ready-made fins for rapid heat dissipation, the housings should provide more efficient heat conductivity because they are an integral part of the tank. Reduced weight, freedom from rust, and tests indicate these aluminum tanks should lower noise and magnetic losses. **Reynolds Metals Co., Richmond 18, Va.**

Versatile Terminal Block . . .

Moduluk, a versatile and reliable terminal block, allows individual modules to be snapped together or apart and then inserted onto a steel track to be locked at each end. The modules, made of *Zytel 31* for low-water absorption, are fitted with solderless, crimp-type contact tips. Thirty of these modules may be mounted per foot of track. **Burndy Corp., Omaton Div., Norwalk, Conn.**

Light Control . . .

By using two General Electric silicon-controlled rectifiers in place of thyratrons, magnetic amplifiers, or autotransformers, the over-all size of this light dimmer has been reduced to as little as $\frac{1}{32}$ cubic foot per 1-kw load capacity. With only 50 watts



of power lost per 4,000 watts of load, the units are virtually free of excessive heat. Other advantages are silent operation and no parts to wear out and replace. **Kliegl Bros., 321 W. 50th St., New York 19, N. Y.**

Series-Multiple Transformer Switch . . .

This series-multiple switch allows increased system voltage without changing transformers. Pole-type transformers from 5 to 167 kva, equipped with this externally mounted switch can be installed at a given line voltage and uprated later when the distribution voltage is raised. The specially designed cap, when removed and reversed, becomes the tool by which the switch mechanism is rotated. **Kuhlman Electric Co., Birmingham, Mich.**

Paystation Carrier Telephone Equipment . . .

Using existing exchange telephone lines, seven additional channels of postpay pay station service are made possible with this equipment without the necessity of running additional lines. Installation economies may be realized for pay station service beyond a 6-mile radius and it is said that under special conditions the equipment is economical within urban areas by postponing cable plant expansion. It is especially suitable for highway pay station installations where it is difficult to predict the best locations for each unit in the system. **Budelman Electronic Corp., 375 Fairfield Ave., Stamford, Conn.**

Megger Insulation Tester . . .

Consisting of a dry-type rectifier with magnetic input voltage stabilizer and a crossed-coil ohmmeter measuring element, this instrument is primarily intended to make step-voltage resistance tests on the insulation of electrical equipment with voltage ratings in the 300-, 600-, and 2,500-volt class. Direct applications include a-c and d-c rotating machinery rated 230, 440, 550, and 2,500 volts, traction motors and generators rated 600 volts, heat resistant insulation rated 600 volts, and dry-type transformers and switch gear. **James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.**

Contour Photocells . . .

These pliable photoelectric selenium cells open new design possibilities by bringing a "third dimension" to photocells. Because it is possible to shape these cells into any curved or cylindrical form, they may be mounted on a rotating shaft as a position control servomechanism or used as a form of nonlinear function generator when formed into a photosensitive cam. Other applications lie in the fields of control devices, production flow processes, and automatic inspection and sorting instruments. **International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.**

Electronic Tachometer . . .

Covering the entire range of engine speeds from $\frac{1}{5}$ to 50,000 rpm, this electronic tachometer has the advantage of indicating rpm's continuously with 5 legible, accurate readings per second. Direct digital readout is provided by Nixie tubes, which convert signals to illuminated numbers. Readout can also be made with cold cathode decade counter tubes. **Dynapar Corp., 5150 Church St., Skokie, Ill.**

Silicone Insulator Spray . . .

When sprayed on insulator surfaces, Insuljel quickly sheds water and encapsulates contamination particles in a moisture-proof seal thereby eliminating low resistance current leak paths when moistened by dew or light rain. The silicone grease is dispersed from an Aerosol container by means of a fast evaporating solvent chosen for rapid drying that is noninflammable for hot-line application. **General Electric Co., P.O. Box 57, Baltimore 3, Md.**

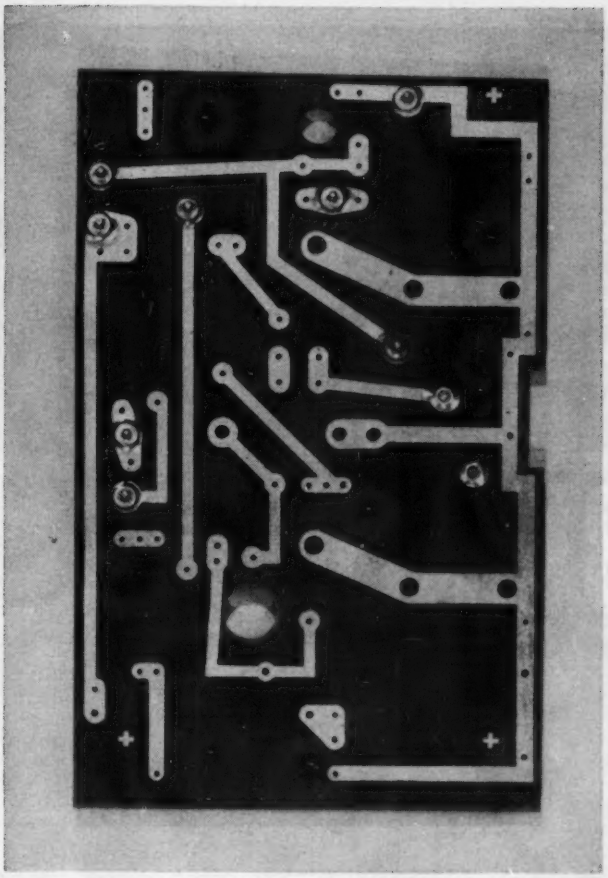
Maximum Flux Density Ferrite . . .

A power ferrite having a maximum flux density in excess of 5,000 gauss promises to open new fields for the application of power ferrites. Exceptionally low hysteresis and eddy current losses afford outstanding performance at frequencies from 400 to 15,000 cps. The W-07 power ferrite has a high Curie point and maximum flux density does not decrease appreciably with an increase in temperature. Its unusual characteristics and lower material costs offer new design possibilities in the fields of ballasts for high-frequency fluorescent lighting, high-speed synchronous and asynchronous motors, and high-frequency power transformers. It permits vast improvement in frequency converters operating at high power levels. **Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.**

D-C Performance on A-C Cranes . . .

Highly efficient silicon rectifiers are used to supply d-c power to a series-wound hoist motor and its series-wound brake. The inherent "blocking" characteristic of the silicon rectifiers automatically increases the motor stability for safe lowering of extreme overloads. **The Electric Controller & Mfg. Co., 4500 Lee Rd., Cleveland 28, Ohio.**

(Continued on page 26A)



How CDF Di-Clad† can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 28E. For high mechanical strength, low moisture-absorption, and good insulation resistance, CDF Di-Clad laminates of epoxy resin laminated with glass fabric offer the designer a strong, reliable combination.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

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*Du Pont trademark for its tetrafluoroethylene resin.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed-circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

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TYPICAL Di-Clad PROPERTY VALUES

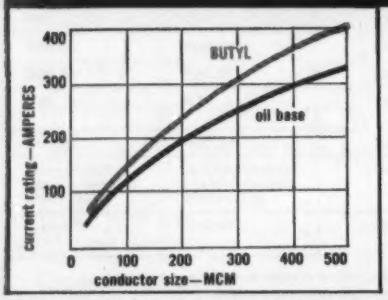
	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

ENJAY BUTYL

BEST WAY TO HANDLE ELECTRICITY



Butyl's outstanding resistance to heat allows considerably higher currents for any given conductor size.

Of all vulcanizable rubbers, Enjay Butyl offers the best electrical and dielectric properties. Butyl is the ideal material for wire and power cable, transformers, tapes, busbars and other insulation applications.

Butyl *also* offers outstanding resistance to weathering and sunlight . . . chemicals . . . abrasion, tear and flexing . . . superior damping properties . . . unmatched impermeability to gases and moisture.

Find out how this versatile rubber can improve your product. Call or write the Enjay Company, today!

ENJAY® BUTYL

ENJAY *Pioneer in Petrochemicals*

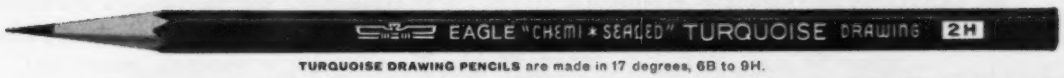
ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

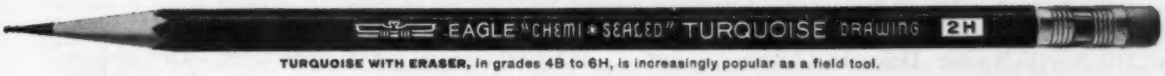
On any drafting material . . .

You draw sharper, clearer with Eagle Turquoise

TURQUOISE LEAD HOLDERS hold any TURQUOISE lead (5B to 9H) in a bulldog grip.



TURQUOISE DRAWING PENCILS are made in 17 degrees, 6B to 9H.



TURQUOISE WITH ERASER, in grades 4B to 6H, is increasingly popular as a field tool.

We've run tests on every drafting material made—including some that aren't even on the market yet! On all of them, TURQUOISE consistently out-performs other pencils.

Here's why: the strong TURQUOISE needle-point stays sharp longer. You get the world's cleanest lines—for the world's sharpest reproduction. TURQUOISE'S "electronic" graphite glides more smoothly (without skipping) over every material. And these superior qualities are combined with perfectly uniform grading—pencil after pencil!

So why switch pencils when you switch drafting surfaces? Standardize on Eagle TURQUOISE!

EAGLE

WANT A FREE SAMPLE? Write for a TURQUOISE lead, pencil, or pencil-with-eraser in the degree you'd like to test on your favorite drafting material. Eagle Pencil Company, Danbury, Conn.

Architect: GRAHAM, ANDERSON, PROBST & WHITE, Chicago, Illinois
Electrical Contractor: HYRE ELECTRIC CO., Chicago, Illinois

Electrical Protection goes MODERN *with BUSS fuses! . . . in the MORTON SALT BUILDING Chicago, Ill.*

The beautiful, new Morton Salt Building is located at 110 North Wacker Drive in Chicago — just outside the Loop.

The safest and most dependable electrical protection was needed because the engineers estimated the available fault current might easily reach a value of 75,000 amperes.

For this reason, the main switchgear, consisting of 1-4000 ampere, 1-2000 ampere and 1-1200 ampere pressure switch, is completely equipped with BUSS Hi-Cap fuses.

To make available the same safe, dependable and trouble-free protection, all distribution panels are equipped with FUSETRON dual-element fuses.

THERE IS A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED

Morton Salt Building: Mains and Feeders protected by BUSS Hi-Cap and FUSETRON Fuses

ONLY FUSES OFFER THE SAFETY AND DEPENDABILITY REQUIRED FOR TODAY'S CIRCUITS

Because of the ever-increasing transformer and network capacities, Power Companies now consider quite possible fault currents of 75,000 to 200,000 ampere.

So too, the requirements for protective devices have been changed to assure safe interruption of these higher fault currents.

Fuses, — because of their high interrupting capacity and dependability — prove superior in meeting modern protection requirements.

With Fuses, Safe Protection Remains Safe

Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time. The operation of a fuse is not dependent on latches, triggers or other devices that are subject to the strains and jars of mechanical action — both in opening and closing.

A fuse cannot stick or fail to operate when electrical trouble occurs. 1 year, 5 years or 20 years from now, a fuse will provide the same, high degree of protection as on the day it was installed.

On installations of 0 to 600 amperes . . .

By Installing FUSETRON dual-element FUSES — YOU GET 10 POINT PROTECTION

With rare exceptions, other types of protective devices protect only against short-circuits —

BUT, FUSETRON dual-element fuses give you safe, trouble-free 10 point protection.

For the FUSETRON fuse story ask for Bulletin FIS.

For Loads above 600 amperes . . .

BUSS Hi-Cap Fuses offer Safest, Most Modern Protection

They have an interrupting capacity sufficient to handle any fault current regardless of system growth — and by coordinating them with FUSETRON fuses on feeder and branch circuits, outages caused by fault currents can be limited to circuit of origin.

For the BUSS Hi-Cap fuse story ask for Bulletin HCS.

BUSSMANN MFG. DIV. McGRAW-EDISON CO. ST. LOUIS 7, MO.

SILICONE RUBBER INSULATED *BY ROCKBESTOS* OFFER YOU:

Excellent dielectric strength — electrical properties remain constant from −130°F to +500°F.

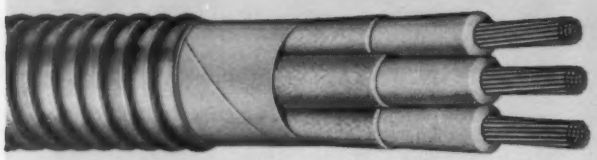
High heat resistance — better than any type rubber insulation. Long service life in temperatures to 125°C (power cables) and 200°C (other applications).

Excellent moisture resistance — unrestricted applications in wet or dry locations — equal to the best grades of rubber. No lead sheath required.

Greater ozone resistance than the best grades of rubber insulated cables.

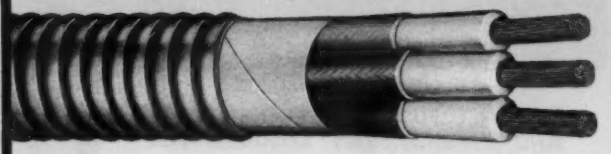
Excellent resistance to chemical attack — being chemically inert, silicone rubber insulations resist effects of lubricating oils and most corrosive atmospheres.

Long life — excellent resistance to weathering and aging.



600 and 5000 VOLT MULTI-CONDUCTOR POWER CABLE

Silicone rubber insulated power cable combined in a 3 or 4 conductor construction, with interlocked armor overall . . . easily installed with simple supports . . . eliminates conduit . . . greater current carrying capacity for economical power distribution.



MULTI-CONDUCTOR CONTROL CABLE

For use in steel mills, power stations, boiler rooms, automotive, ceramic and glass plants as well as other industries where control and signal circuits or control equipment are exposed to high ambient operating temperatures.

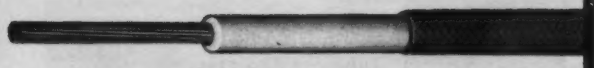
ROCKBESTOS PRODUCTS CORPORATION, NEW HAVEN 4, CONNECTICUT

NEW YORK • CLEVELAND • DETROIT • CHICAGO • PITTSBURGH • ST. LOUIS • ATLANTA • DALLAS
SEATTLE • LOS ANGELES • BURLINGAME, CALIFORNIA

WIRES

SILICONE RUBBER INSULATED POWER CABLE 600 and 5000 VOLTS

For high temperature circuits either in wet or dry locations, exposed or in conduit. This cable is recommended for use in steel mills, power stations, heat treat areas, boiler rooms, foundries, smelters, etc.

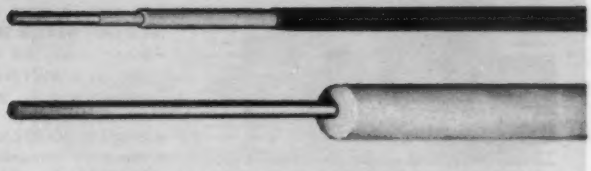


MOTOR LEAD and APPARATUS WIRES

For leads to motors, transformers, etc., requiring a flexible wire in high temperature locations or applications.

APPLIANCE and FIXTURE WIRES

For use in wiring high wattage units when operating temperatures reach 150°C and 200°C. Lighting fixtures, clothes dryers, electronic equipment, stoves, water heaters, ovens, therapeutic devices, space heaters are among the many products for which these wires are recommended.

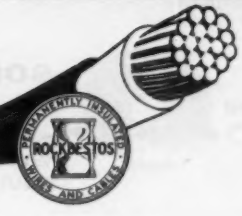


HEATING CABLES and DEFROSTING WIRES

Heating cables are ideal for use in pipe heating, surface heating, roof de-icing and soil heating.

Defroster wires being odorless and tasteless are perfect for use as rapid defroster heating element in electric refrigerators and freezers.

ROCKBESTOS

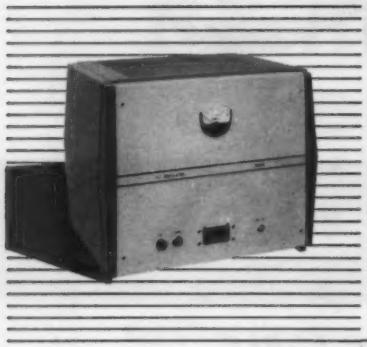


For complete details on Rockbestos Silicone Rubber Insulated Wires and Cables send for Catalog SR58.

NEW IDEAS IN PACKAGED POWER

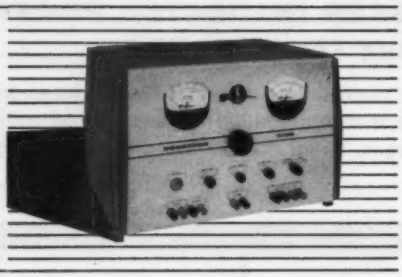
for lab, production test, test maintenance, or as a component or subsystem in your own products

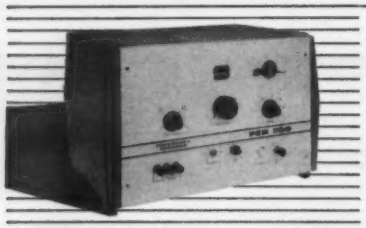
Look how Sorensen equipment blankets the controlled power field:



A-c regulators
- Completely tubeless—transistorized and mag-amp to 5 kva
- Tubeless for peak, rms or average voltage
- Electronic—to 15 kva
- Fast-response, low-distortion
- High-precision (±0.01% rms regulation)
- Hermetically sealed and MilSpec versions
- 400-cycle regulators
- Three-phase
- A-c meter calibrators and voltage reference sources
- "Constant voltage transformers" for line and filament regulation

NOBATRON® regulated d-c supplies
- B supplies
- Tubeless low-voltage, high-current—to 500 amps out
- Wide range—electronic, transistor or mag-amp controlled
- Electronically regulated d-c supplies
- Miniature transistor-regulated supplies
- And also unregulated d-c supplies





Model R5010 Tubeless AC Line Regulator (top)
Model 610B Nobatron DC Supply (center)
Model FCR 250 Frequency Changer (bottom)

Frequency changers, inverters, converters (no moving parts in these)
- Single-phase, 60 cps to single-phase 400 cps or any f in range 45-2000 cps—adjustable f or ±0.001% regulated; powers to 1000 va
- Single-phase 60 cps to three-phase 400 cps
- Miniature transistorized inverters—6, 12, or 28 vdc to 115 vac, 60 or 400 cps
- Miniature transistorized converters—6, 12, or 28 vdc to d-c voltages from 50 to 1000 vdc

Although Sorensen originally made its name as the foremost producer of electronic a-c line-voltage regulators, we've come a long way since then. Today, Sorensen standard units, as outlined above, fill almost all the requirements of the controlled power field—and you can add to these Sorensen's high-voltage equipment (up to 600 kv). Today's Sorensen engineer is equally at home in designing with vacuum tubes, semiconductors, and the latest magnetic devices and materials to produce better, lighter, faster controlled power equipment than ever before. Sorensen engineers are always glad to discuss your special power requirements with you—whether for a new unit or for a complete power system. Write us or see your Sorensen representative.

8.44

Sorensen

SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

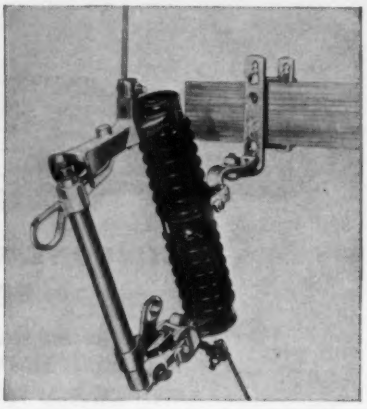
IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. **IN WESTERN CANADA,** ARVA. **IN EASTERN CANADA,** Bayly Engineering, Ltd. **IN MEXICO,** Electro Labs, S. A., Mexico City.

New Products

(*Continued from page 18A*)

Distribution Cutouts . . .

This type of extra heavy-duty cutout has pressure controlled venting for interrupting both high- and low-fault currents. High-fault currents cause a disc to blow out of the expendable cap at the top of the tube, venting the gases at both ends of the tube and preventing tube rupture. Low-fault currents are cleared by venting



the gases at the bottom only of the fuse tube, with the expendable cap remaining intact. Interrupting ratings are 10,000 amperes at 7.8 kv. **James R. Kearney Corp., 4236 Clayton Ave., St. Louis 10, Mo.**

Tubeless Photoelectric Control . . .

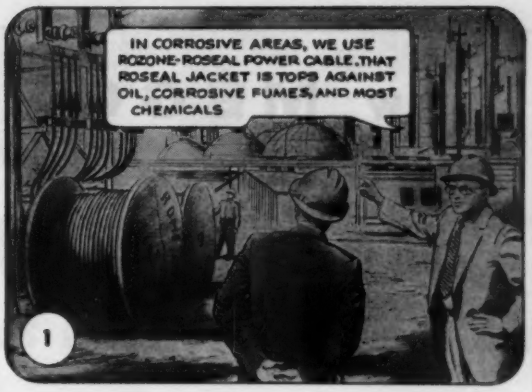
Relatively high-speed photoelectric operation is provided by a new control utilizing a cadmium-cell sensing element with a magnetic amplifier. The new control requires 10 foot-candles minimum light with 0.04 second minimum dark time and 0.04 second minimum light time. Relay contacts are double-pole double-throw, silver cadmium oxide, rated 10 amperes at 115-volts a-c, noninductive load. **Autotron, Inc., P.O. Box 722B, Danville, Ill.**

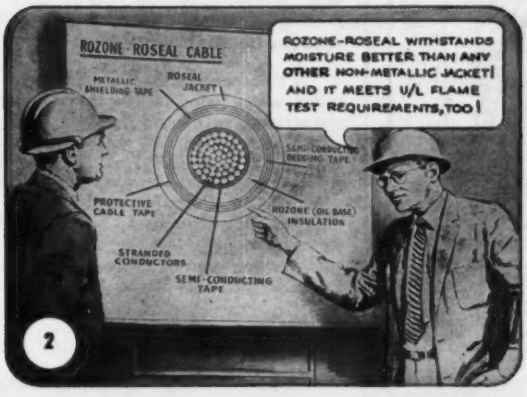
Fast Switching Mesa Transistors . . .

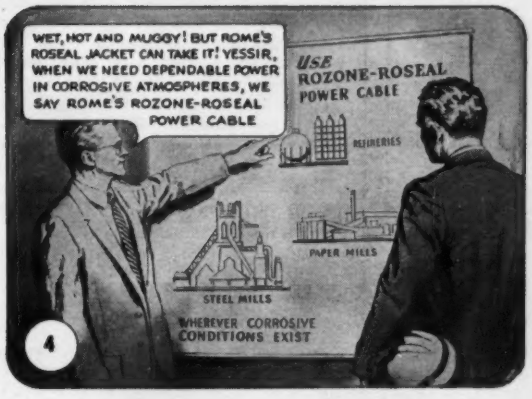
Originally developed and produced by Bell Telephone Laboratories for high-reliability operation in the most exacting military missile and airborne electronic circuits, the *2N559* meets and exceeds all reliability specifications as outlined in *MIL-T-19500A*. Switching speeds into the millimicrosecond range and a typical alpha cutoff frequency of 250 mc make this ultrahigh-frequency, diffused base "mesa" germanium transistor ideally suited for ultrahigh-speed switching applications. **Texas Instruments, Inc., P.O. Box 312, Dallas, Texas.**

(*Continued on page 28A*)

DANGER! CORROSION AT WORK...


IN CORROSIVE AREAS, WE USE ROZONE-ROSEAL POWER CABLE. THAT ROSEAL JACKET IS TOPS AGAINST OIL, CORROSIVE FUMES, AND MOST CHEMICALS
1




WET, HOT AND MUGGY! BUT ROME'S ROSEAL JACKET CAN TAKE IT! YESSIR, WHEN WE NEED DEPENDABLE POWER IN CORROSIVE ATMOSPHERES, WE SAY ROME'S ROZONE-ROSEAL POWER CABLE
USE ROZONE-ROSEAL POWER CABLE
REFINERIES
PAPER MILLS
STEEL MILLS
WHEREVER CORROSIVE CONDITIONS EXIST
4

Available in voltage ranges through 15 kv Rozone-Roseal preferred power cable may be installed in air, conduit, underground ducts, or directly in earth. Your choice of premium ozone-resistant insulations: Rozone (oil-base) or Rozone A (butyl-base). For complete information, contact your nearest Rome Cable representative and ask for Bulletin RCD-700. Or mail the coupon today.

ROME CABLE
CORPORATION

A matter of FACT

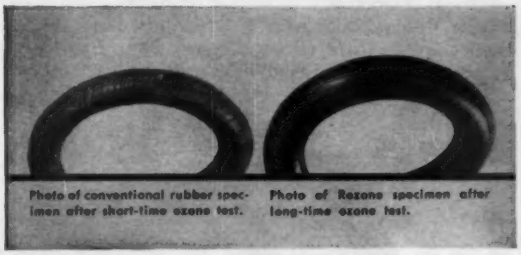


Photo of conventional rubber specimen after short-time ozone test. Photo of Rozone specimen after long-time ozone test.

Rozone insulation is high in dielectric and impulse strength and has excellent resistance to corona and ozone cutting.

FREE BULLETIN describes the benefits of Rome's preferred high-voltage power cables.

ROME CABLE CORPORATION
Department 720, Rome, New York

Please send me a copy of the new Rome Cable Bulletin RCD-700.

Name .....

Title .....

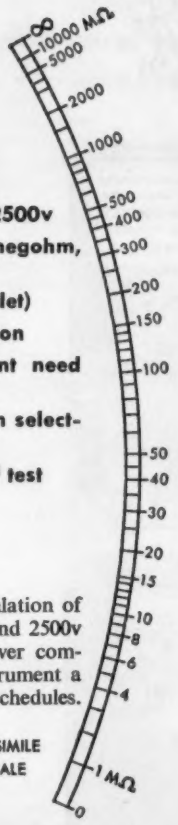
Company .....

Address .....

.....

Type of business .....

New MEGGER®
INSULATION TESTER
. . . 6-Voltages
. . . Rectifier Operated



FEATURES

- six output voltages 500, 750, 1000, 1500, 2000, 2500v
- single scale, wide resistance range 0-10,000 megohm, easy to read
- rectifier-operated (plug-in to standard lighting outlet)
- excellent output voltage stabilization and regulation
- extremely rugged measuring system—instrument need not be leveled, fast indication
- single output voltage selector switch—no errors in selecting test voltage
- automatic discharge of tested insulation at end of test
- easily portable, moderate size and weight

APPLICATION

Ideal for making step-voltage resistance tests on the insulation of electrical equipment with voltage ratings in the 300, 600 and 2500v classes. Maintenance men in large industrial plants, power companies and railroad electrical repair shops find this instrument a real time saver where many tests must be made on tight schedules.

FACSIMILE SCALE

Write for BULLETIN 21-20a-EE

B908

JAMES G. BIDDLE CO.

Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

New & Improved Products

(*Continued from page 26A*)

Ultrasonic Quality Control Tester . . .

Interior flaws, discontinuities, and foreign inclusions in metal or plastic sheets and laminates are quickly spotted by this ultrasonic quality control tester. These imperfections are revealed on the cathode ray tube as extra traces. Scales placed across the tube's face show the exact depth of the imperfections. The instrument may also be used to determine the sheet's thickness. **Branson Instruments, 40 Brown House Rd., Stamford, Conn.**

Attachable Overload Protector . . .

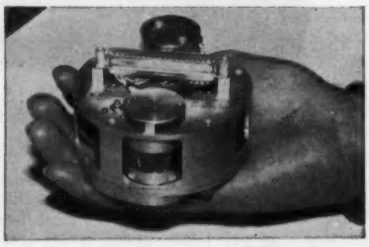
A fractional horsepower overload protector which trips in response to rising temperature or excessive current draw is particularly adaptable to fans, disposal systems, air conditioning, refrigerators, freezers, pumps, and other equipment. The *MP-1620* is attached to the surface of motor housing with a steel box bracket or clamp that goes under the head of one of the motor's through-bolts. **Mechanical Products Inc., 1824 River, Jackson, Mich.**

Wire Stripping Tool . . .

Nylon sheathing is stripped from plated copper-braid wire without scoring the braid with this new tool. Two high-speed steel blades sharpened to the helix angle of the twisted wire penetrate the nylon to the proper depth. The angle of the cutting blades and the elongated slot in the wire guide induce a spiral motion to the wire as it is drawn over the area to be stripped. The two cuts release tension in the nylon, thus permitting it to be peeled off easily. **Stavid Engineering, Inc., Rt. 22, Plainfield, N.J.**

Miniature Tape Recorder . . .

This ruggedized airborne tape recorder weighing only 24 ounces has been tested under actual operating conditions for vibration of 15 times gravity and impact of 2,000 g. Applications include in-flight tests, static tests, blast and explosion



studies, wind tunnel studies, acceleration and actuation tests, oil well logging and atmospheric studies. **Leach Corp., 18435 Susana Rd., Compton, Calif.**

(*Continued on page 36A*)

WHAT? makes the DIFFERENCE

The KNOW-HOW that is not in any Formula

RESEARCH

For over 50 years scientists in the NIFE Laboratories have been learning the FACTS about the electro-chemical characteristics of the metals — nickel and cadmium.

EXPERIENCE

NIFE engineers around the world, from 50 years experience, have learned how to handle the construction of Storage Batteries; to design properly the RIGHT TYPE for each application.

The Sum of Research and Experience is KNOW-HOW

The *Original* NICKEL CADMIUM BATTERY

Grand River Dam Authority
Miami, Oklahoma

WHAT MAKES the DIFFERENCE?

In heat or cold a NIFE Battery is there with SURE GUARANTEED EMERGENCY POWER. It is IMMUNE to excessive DISCHARGES and SHORT CIRCUITS WITH NO BUCKLING OF PLATES, is NOT RUINED by such abuses as UNDER CHARGING, OVER CHARGING, DEEP CYCLING, way below FREEZING TEMPERATURES, EXCESSIVE HEAT and long periods of IDLE STORAGE with no 'trickle charge'. There are NO CORROSIVE GASES. A NIFE Battery is not damaged by SHOCK or VIBRATION.

You must investigate the *original Nickel Cadmium Battery*. THERE IS A DIFFERENCE!

NICKEL CADMIUM BATTERY DIVISION OF

NIFE INCORPORATED

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Treats applied transistor electronics, its internal physical behavior, and the structure of equivalent circuits, *plus* the theory and dynamics of switching.

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Industrial Notes...

Dynex, Inc.
Hicksville, L. I., N. Y...

This company has moved its complete operation from Westbury, L. I. to larger quarters at 200 Frank Rd., Hicksville. The entire staff was moved and personnel is being increased to include highly specialized engineers who will concentrate on researching and developing equipment for particular uses in electromechanical instrumentation. All the equipment designed, engineered, and manufactured by Dynex is applicable for use in industrial, commercial, and military fields for data processing equipment, computers, automation systems, and related electronic and electromechanical devices.

National Cash Register Co.
Dayton, Ohio . . .

A data processor and a battery of other machines will prepare customers' statements at the rate of 50 per minute for R. H. Macy & Co., Inc., department store, New York City. This will be 25 times faster than the present speed and will enable customers to receive their bills at least a week earlier. The electronic system is also expected to cut record-keeping costs and provide the company with operating information for all six stores in its Macy's New York Division. The system was developed by the National Cash Register Co., South Maine and K Sts., Dayton 9, Ohio.

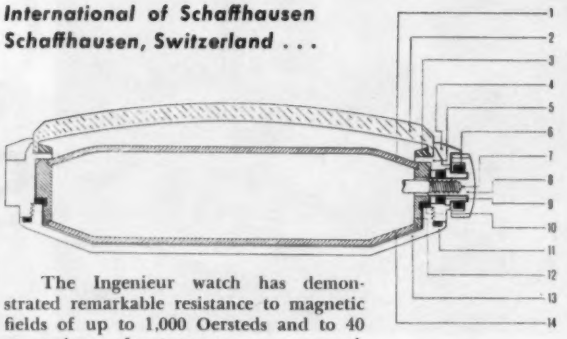
AA Gage Co.
Detroit, Mich. . .

Establishment of a design engineering service, to be known as AA Industries, has been announced by AA Gage Co., 350 Fair St., Detroit 20, Mich., manufacturers of precision inspection equipment, gauges, marking machines, special machines, and tooling. In announcing the new subsidiary, officials of AA Gage said that an outstanding advantage of their service will be the practical shop experience of their engineers. This will result in designs that will be both practical and workable, as well as less expensive to build.

Silvray Lighting, Inc.
Bound Brook, N. J. . .

Long ribbons of light are being used in fashion shows to eliminate harsh, glary spotlights. This portable system of high-level illumination utilizes powerful fluorescent lamps manufactured by Silvary Lighting Inc., Bound Brook, N. J. Using chains that easily slip on and off the screw eyes, the lighting system can be set up or taken down in a half hour or less. The Indirect Luminous Ceiling units are said to be the first to harness the tremendous power of General Electric's power groove fluorescent tube, which gives two and a half times more illumination than conventional lamps of the type.

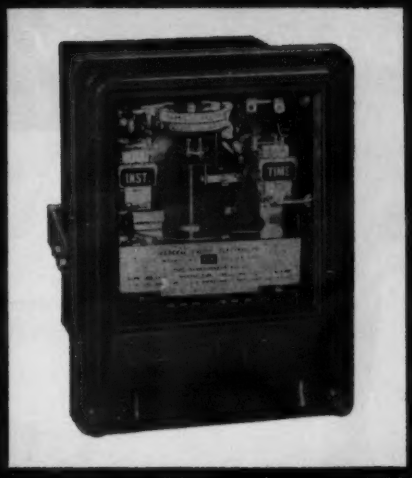
International of Schaffhausen
Schaffhausen, Switzerland . . .

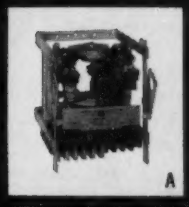


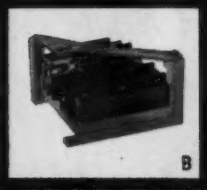
The Ingenieur watch has demonstrated remarkable resistance to magnetic fields of up to 1,000 Oersteds and to 40 atmospheres of water pressure, corresponding to 400 feet below sea level. The inner mantle, which envelops the entire movement, is made of a special alloy and comprises the cover (1), the ring (12), and the bottom (14). This inner magnetic cage affords the strongest possible protection against magnetic influences making this watch a perfect timepiece for engineers, radiologists, technicians, scientists, researchers, and others exposed to strong electric or electronic equipment. In addition to the special double-casing, the Ingenieur is sealed against water, moisture, and acids making it thoroughly waterproof and resistant to extreme temperature changes and other hazards which might affect the accuracy of any other watch. For this reason, it is favored also by explorers and sports enthusiasts. The sealing is accomplished as follows: the bottom (13) of the outer case is bolted down with two sealing rings (10 and 11). The shatterproof crystal (2) is surrounded by a glass ring (4) reinforced by a steel ring (3) to insure a watertight seal. The winding crown (8), slightly recessed in the case center, is sealed by two sealing rings (6 and 9) in the head of the winding crown and between crown neck and case center. The Ingenieur has a 21-jewel automatic self-winding movement. It is available in stainless steel, 18 karat gold, or combinations of steel and gold. Calendar features are also available. The Ingenieur is manufactured by International of Schaffhausen, and is distributed in the United States by the Henri Stern Watch Agency, 587 Fifth Ave., New York 17, N. Y.

(Continued on page 34A)

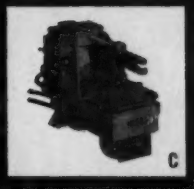
Reliable Protective Relays

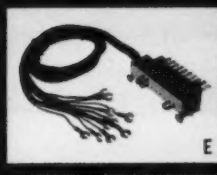






...the heart of quality switchgear





This proud new line of protective relays makes Federal Pacific one of only three companies able to furnish all major switchgear components, thus providing for complete quality control and undivided responsibility.

Featuring utmost reliability as well as unusual sensitivity, stability, accuracy, and simplicity, there are only three basic movements—induction disk, induction cup, and hinged armature. Any desired a-c relay characteristic can be provided through variations of the induction disk and induction cup units. What's more, these relays are designed for minimum maintenance and testing time.

A—BASIC INDUCTION DISK UNIT. Used with relays requiring adjustable time characteristics. Note separate connector on bottom which permits removal of the mechanism from the case by merely sliding it forward. No parts need be removed or wires disconnected.

B—BASIC INDUCTION CUP UNIT. This basic unit is used for instantaneous relaying applications where operating times of a cycle or less are required.

C—BASIC HINGED ARMATURE UNIT. Extremely flexible unit for use with a-c or d-c, current or voltage—with hand, self, or electrical reset contacts, circuit opening or closing, or combinations.

D—OPERATION INDICATORS. All induction relays have a combined electrical operation indicator and seal-in contactor of hinged armature design.

E—TEST PLUG. Permits complete secondary tests and checking of all connected circuits. Insertion of the plug instantly transfers relay to test circuit, removal automatically restores relay to service. Alteration of links or connections on the panel is avoided—testing is reduced to a fraction of the time normally required.

Rugged... simple... precise... and reliable. Yes, these new protective relays are worthy of your trust—as is all Federal Pacific electrical distribution and control equipment. Get the best! Write for Relay Bulletin 5-020, Federal Pacific Electric Company, General Offices: Dept. 290, Newark 1, New Jersey.

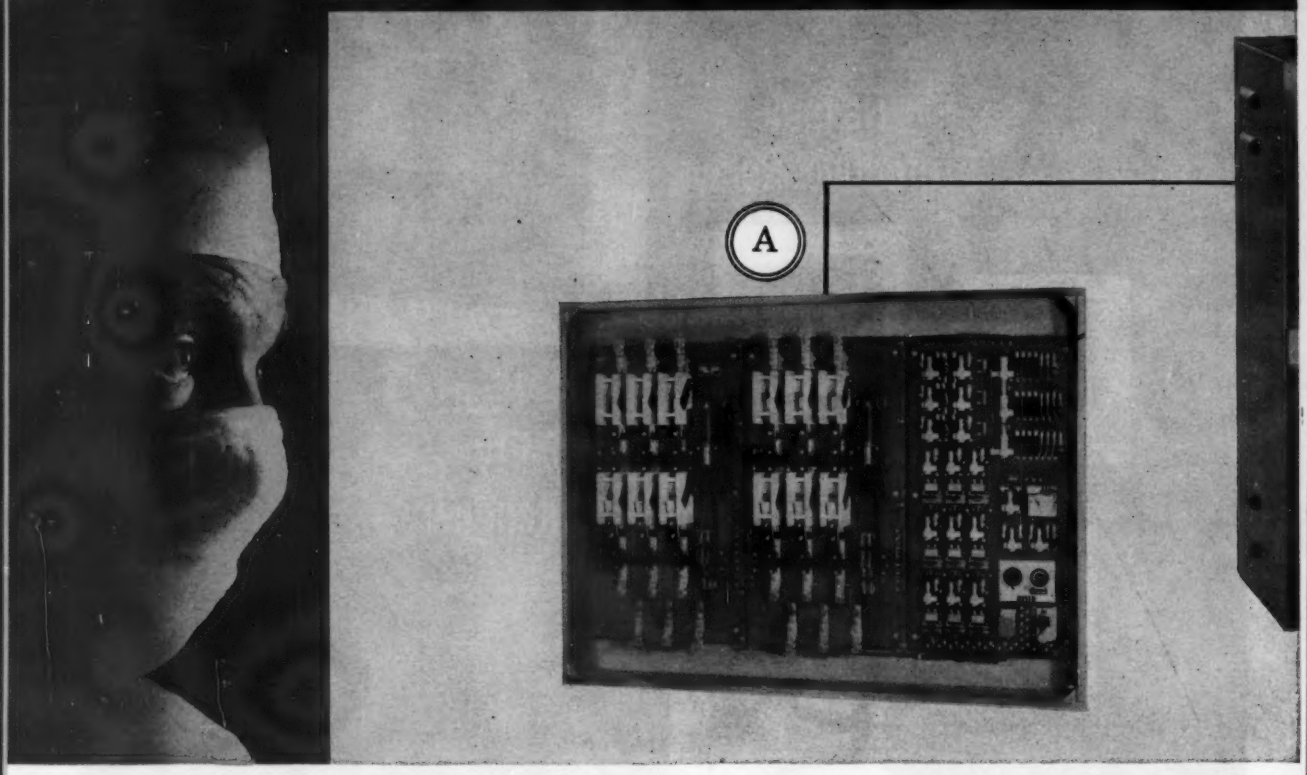
FPE

FEDERAL PACIFIC ELECTRIC COMPANY

The Best in Electrical Distribution and Control Equipment.

WHEN POWER

ASCO COMPLETE CONTROL SYSTEMS PUT



Here's how ASCO control system operates . . .

ASCO Automatic Transfer Switches, with built in selected time delay of ½ to 3 seconds, ignore momentary outages caused by transient conditions – thus protect generating equipment from false starts. However, once a sustained outage is detected, ASCO Control Systems put standby power in action – fast. Follow the cycle, step by step . . .

STEP 1 The instant a sustained outage is detected, a contact on the ASCO Automatic Transfer Switch (A) closes.

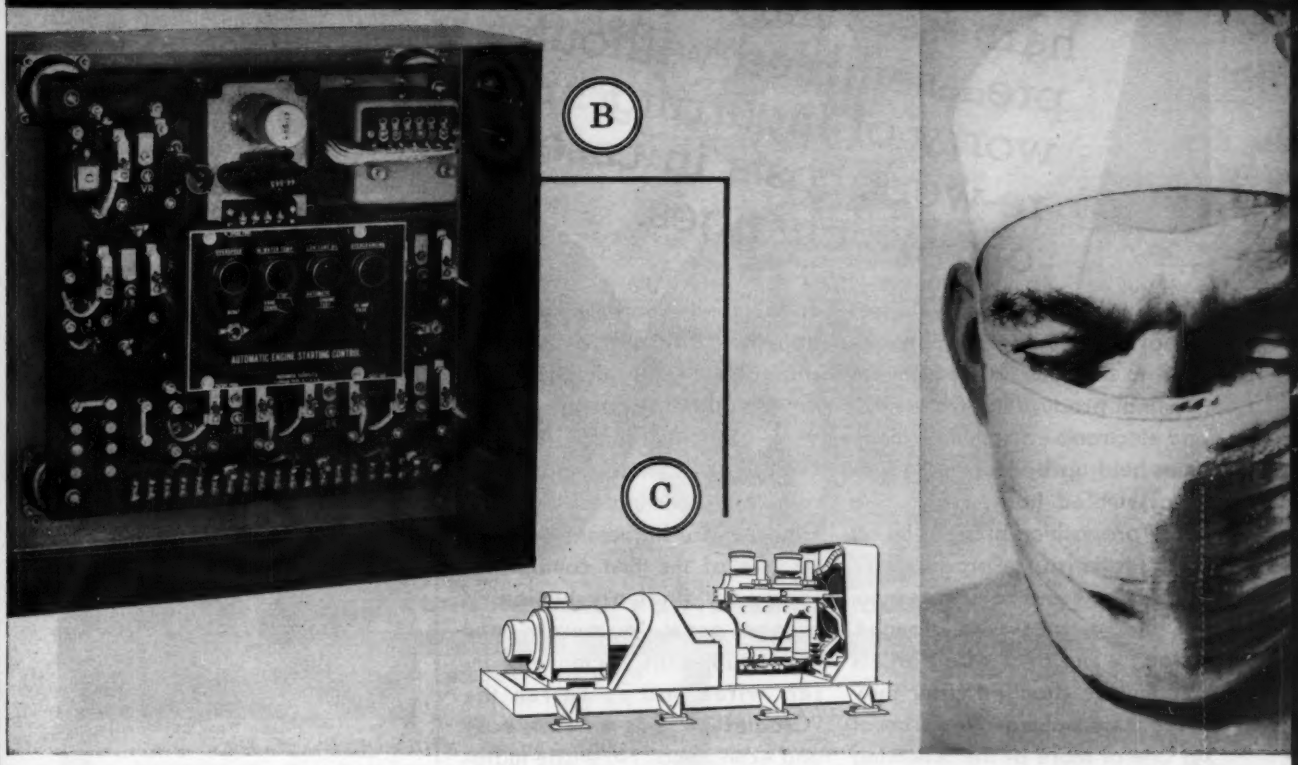
STEP 2 This energizes the ASCO Automatic Engine Starting Control (B), which opens the fuel control device on the generator and cuts in batteries to energize the starting motor and crank the engine (C).

Four on-off cranking cycles are provided. When the engine fires, the starting control automatically disconnects the cranking control.

STEP 3 When standby power source reaches proper voltage and frequency, the transfer switch transfers the load to the electric plant. Time of transfer – 1/30 to 1/6 of a second!

When normal power is restored, the ASCO Transfer Switch returns the load to its original feeder lines. The Starting Control then causes the electric plant to shut down.

STANDBY POWER IN ACTION – FAST



For Dependable Standby Power, **ASCO designs and manufactures a complete line of emergency power and electric plant control equipment. In addition to Automatic Transfer Switches and Automatic Engine Starting Controls, this includes:**

Solenoid Valves: **For air starting applications, and for controlling the flow of cooling water, fuel oil and other liquids and gases.**

Battery Chargers: **To keep starting batteries charged, ready for engine starting.**

Solenoids: **For fuel control devices, operating shutters for engine cooling, and other electric plant applications.**

Load Demand Controls: **To automatically start engine when load is applied; stop it when load is removed.**

For Detailed Information write for:

Catalog 57-S1 – Automatic Transfer Switches

Catalog 57-S5 – Solenoids

Catalog 57-S6 – Electric Plant Controls (including battery chargers)

Catalog No. 25 – Solenoid Valves

Dependable control by ASCO

Automatic Switch Co.

50-K Hanover Road, Florham Park, New Jersey • Frontier 7-4600

AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

MEMO TO: ENGINEERING AND PRODUCTION DEPARTMENTS

. . . from prototypes to production runs . . . wire harnesses may now be preassembled without worry of incurring high re-work costs in case of wire changes.

The assembly of wire harnesses has always been a major headache to production departments . . . final production of electrical and electronic equipment is many times held-up because of a lack of assembled harnesses . . . a costly proposition brought on by the hesitation to pre-produce wire harnesses because of unforeseen, but sure to come, wire changes. In fact, 4 out of 5 wire harness designs are changed after they reach the production department for one or more of the following reasons . . . faulty design, wireman's mistake, customer amendment, or changes to include a new component. Re-work costs on laced wire harnesses are extremely costly and it is understandable that production is delayed until the last possible minute.

The use of "Insuloid Cradleclips" completely eliminates this problem . . . wire harnesses can now be one of the first components ready for final production. If changes occur, you merely open the "Cradleclips," remove or insert wires and re-fasten the "Cradleclips" . . . it's fast, easy and economical. No waste material . . . labor costs are minute. The use of "Cradleclips" could save your firm at least 52% of your yearly wiring costs.

WIRE BETTER, FASTER AND MORE ECONOMICALLY

with the Insuloid cradleclip WIRING SYSTEM

TRADEMARK

Tests conducted by an independent Time Study organization provide positive proof of the great savings of time and materials that can be realized through the use of "Insuloid Cradleclips" in the assembly of wire harnesses. Free copies of this report are available . . . write today for your Time Study Report and free "Cradleclip" samples . . . there's no obligation of course.

a product of

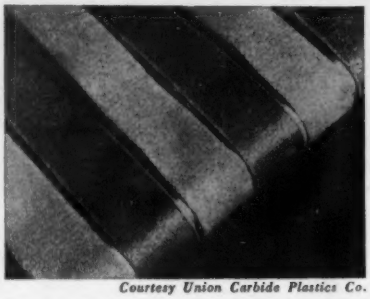
ELECTROVERT INC. 124 EAST 40TH ST. • NEW YORK 16, N. Y.

Industrial Notes

(*Continued from page 30A*)

Union Carbide Corp. New York, N. Y. . .

A new type of bearing made of fabric impregnated with Bakelite phenolic plastic is eliminating the need for lubrication of bearings in mechanical applications ranging from miniature instruments to hydroelectric stations. In some instances, such bearings have outlasted the life of conventional metal bearings by as much as eight times. Ruslon bearings, as they are called, made by the Russell Manufacturing Co., Middletown, Conn., can replace many conventional metal-to-metal bearings, which must be regularly serviced with grease or oil. The major use of the new bearings, the manufacturer predicts, will be in the automotive field where knuckle and ball joints will function for the life of the car without lubrication and without appreciable wear. The new bearings employ both plastic and cotton yarns woven into fabric and then immersed in a solution of phenolic resin. The latter is a high-strength, heat-resistant form of plastic designated *BLS-2680* by the supplier, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N. Y. The



Courtesy Union Carbide Plastics Co.

combination of Bakelite phenolic and fabric also supplies strength in a permanently infusible form, is lightweight, resistant to high temperature, dimensionally stable under most atmospheric conditions, and has a low coefficient of friction.

The metals division of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y., is now called Union Carbide Metals Co. This change of name from Electro Metallurgical Co. is another step in the program designed to identify all of the divisions more closely with the present corporation.

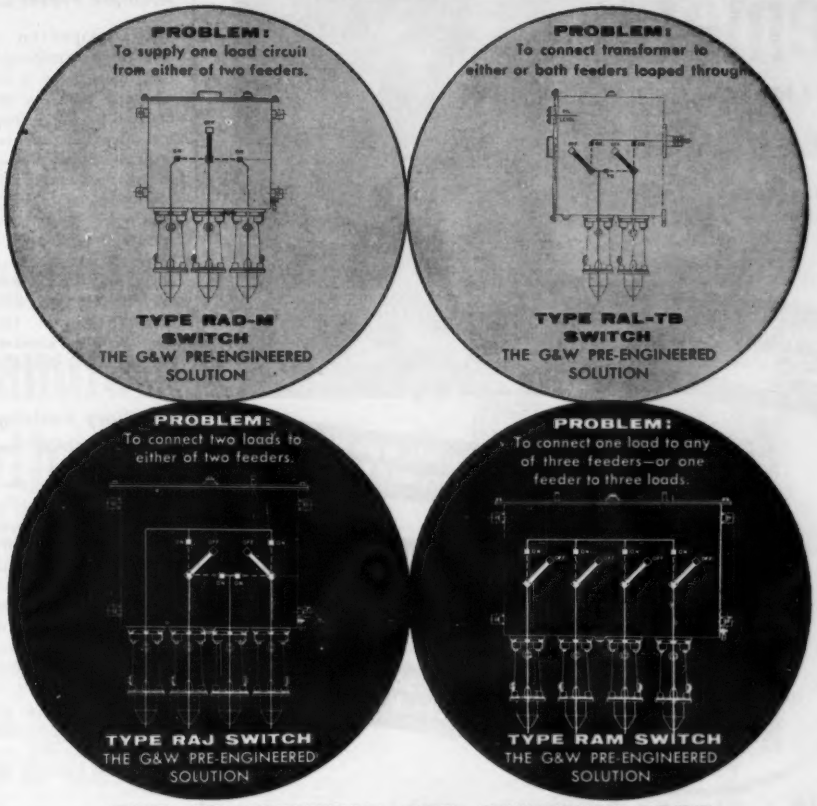
Houston Instrument Corp. Houston, Texas . . .

The Houston Instrument Corporation has been organized for the development, manufacture, and sale of laboratory instruments and specialized industrial instruments for the petroleum and chemical industries. It will have offices at 1717 Clay Ave., Houston 3, Texas.

(*Continued on page 44A*)

examples of G&W

distribution system flexibility


PROBLEM:
To supply one load circuit from either of two feeders.
TYPE RAD-M SWITCH
THE G&W PRE-ENGINEERED SOLUTION
PROBLEM:
To connect transformer to either or both feeders looped through
TYPE RAL-TB SWITCH
THE G&W PRE-ENGINEERED SOLUTION
PROBLEM:
To connect two loads to either of two feeders.
TYPE RAJ SWITCH
THE G&W PRE-ENGINEERED SOLUTION
PROBLEM:
To connect one load to any of three feeders—or one feeder to three loads.
TYPE RAM SWITCH
THE G&W PRE-ENGINEERED SOLUTION

PRE-ENGINEERED FOR MINIMUM COST

Pick a distribution system problem—and you'll find a basic G&W Load Break Oil Switch that's *pre-engineered* to solve it. G&W switches are made of standardized parts designed so they can be combined in a vast number of forms to handle specific by-passing, disconnecting, or fusing requirements. They allow you to meet the needs of individual load centers without the expense of individual engineering. Here is something new in distribution system flexibility—at lower cost that helps you keep construction and installation expenses down. Don't overlook the opportunities G&W pre-engineered load break oil switches offer for simple solutions to sectionalization problems at significant savings. Switches and combination units are available rated from 600 to 34,500 volts, 400 to 1000 amperes continuous capacity, 400 amperes load-break. Special switches to 69,000 volts can be furnished.

SEND TODAY FOR OUR NEW SWITCH FOLDER
Contains the "inside story" on safe, flexible, low-cost distribution system sectionalization.

G&W ELECTRIC SPECIALTY COMPANY
3510 West 127th Street, Blue Island, Illinois
Representatives in principal cities. Canadian Mfr.—Powerlite Devices, Ltd., Toronto

REMOTE INSTRUMENTATION & CONTROL

Telemeter
CONTINUOUSLY
from Remote Points

Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Compatible with most Transducers and Recorders

Tone Multiplex plus Telemetering in Single Package

Includes 10%, 50%, and 90% System Check Voltages

Accurate HIGH-SPEED Analog Telemeter for VOLTS AMPS WATTS PRESSURE FLOW TEMPERATURE etc.

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, or other transducers with a DC mv output, to an output of 10 to 30 cps. If multi-channel operation over a single communication circuit is required, the 10 to 30 cps signal is used to modulate a built-in frequency shift tone channel. The Model 1090 Telemeter Receiver detects and demodulates the transmitted signal and generates a DC current or voltage which varies in exact accordance with the telemetered functions. The receiver output may be directly applied to either recorders, indicating instruments, or both.

The equipment is conservatively designed for continuous duty operation. The over-all accuracy of the Telemeter is 1% with a speed of response of one second.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

WE CAN HELP YOU — Our Applications Department is ready to assist you in your control, telemetering or communications problem.

Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U. S. A.

New & Improved Products

(Continued from page 28A)

Multiple Preset Counter . . .

Developed for counting and sequential predetermining control applications, this instrument is suited for applications where a machine or a process is started manually and stops automatically at several preset counts in one operation. A typical application is in winding tapped torodial or transformer coils. This multiple preset counter has a maximum 4-digit count of 9,999, operating at counting speeds of 4,000 per second, and presets one through six. Various inputs supplied include photocell, switch closure, and pulse. Output is a relay double-pole, double throw, 5 ampere, 105-125 volt power supply. **Freed Transformer Co., Inc., 1700 Weirfield St., Brooklyn 27, N.Y.**

Auxiliary Switchgear and Circuit Breaker Switch . . .

An auxiliary switch *Q-10*, for circuit breaker and switchgear applications, is smaller than its predecessor but has the same electrical rating thereby permitting shorter, narrower stackings of units for substantial space savings. The switch can be individually adjusted in the field in steps of 15 degrees without disassembling or using special tools. Now used on the 4.16-kv Ruptair circuit breaker, Type *MA*, and on the 600-volt, low-voltage air circuit breaker, Type *LA*, the device is available for all secondary control voltages of 24, 48, 125, 250 volts d-c, and 110, 220, 440 volts a-c. **Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.**

Microminiature Mercury Battery . . .

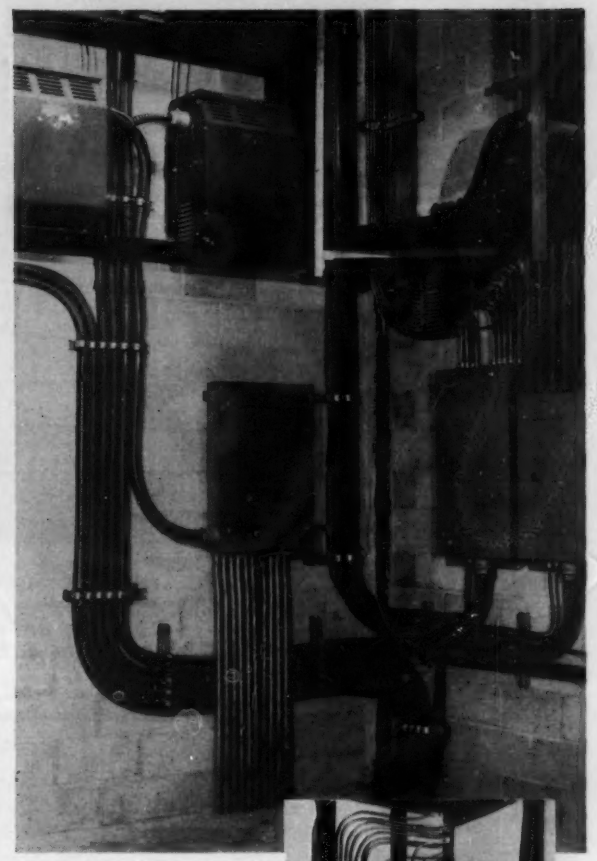
Said to be the smallest battery manufactured for commercial use, this mercury battery is designed to fit the dimension requirements of the military micromodule

program. Its indicated uses include extremely small hearing aids, portable radiation detectors, and other miniaturized electronic devices. Energy life is approximately 36 milliampere hours at a discharge of 2 milliamperes, at 1.22 average volts. **Mallory Battery Co., 13000 Athens Ave., Cleveland, Ohio.**

(Continued on page 38A)

the right combination for industrial power needs!

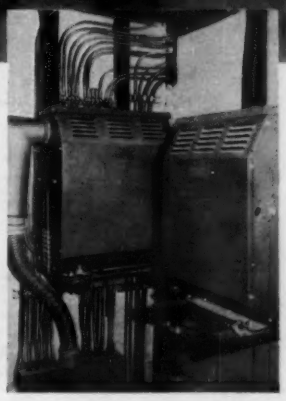
Only General Cable manufactures both...



Installation at the St. Regis Paper Company, Jacksonville, Fla. plant.

TYPE M.I. CABLE

for distribution, control and lighting circuits



INTERLOCKING ARMORED CABLE

for primary power feeder circuits

Easy to install in all locations, both Safety M I Cable and Interlocking Armored Cable require no mechanical protection, thus lowering costs of installation and minimizing space requirements. These constructions are easy to train around equipment or structural members, assuring the absolute minimum of interference, and present a neat, functional appearance. In addition, Safety M I Cable has unequalled physical and electrical properties: it is completely resistant to moisture, aging, nearly all chemicals, and operates at continuous high temperatures. For truly modern wiring in your plant, specify Safety M I Cable and Interlocking Armored Cable. And remember; only General Cable makes them both.

GENERAL CABLE CORPORATION 420 Lexington Avenue, New York 17, N. Y.
Offices and Distributing Centers Coast-to-Coast

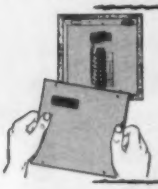
for quality and service... **specify GENERAL CABLE**

*GTC ...THE UNITIZED COMMUNICATION SYSTEM...

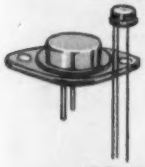
*an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.

COMPLETELY TRANSISTORIZED AND DESIGNED TO MEET THE CRITICAL REQUIREMENTS OF INDUSTRY

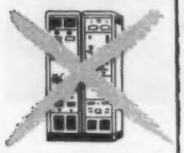
1. An effective, economical industrial communication system designed to provide swift and sure voice communication under adverse environmental conditions such as extremes of temperature and noise.



2. All amplifiers are "plug-in" contributing greatly to ease of installation and MAINTAINABILITY.



3. Transistors and rugged, industrial type components are used throughout. No vacuum tubes or "entertainment" type components of any kind are employed.



4. Central Control cabinet is eliminated thus reducing space requirement to a minimum.

5. ULTRA SIMPLE WIRING PLAN (no shielded cables) and UNITIZED EQUIPMENT with integral terminal facilities make for EASY LOW COST INSTALLATION and LATER EXPANSION.

* GAI-TRONICS TRANSISTORIZED COMMUNICATIONS

GAI-TRONICS CORPORATION
Dept. B
READING, PENNA.
A SUBSIDIARY OF GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet and name of nearest representative.

New & Improved Products

(*Continued from page 36A*)

Easy-to-Operate Data Integrator . . .

Combining fixed information in the form of punched cards with variable data introduced by keyboard to produce a single block of information, the punched tape output can then be fed directly to a computer or to tape-to-tape or tape-to-card converters for a high-speed computer. **Taller & Cooper, Inc., Div. American Electronics, 75 Front St., Brooklyn, N.Y.**

Dual-Beam Oscilloscope . . .

A dual-beam oscilloscope, capable of displaying x-y plots and simultaneously displaying either the x- or y-signal against time, features a unique switching arrangement that develops nine major modes of display. By introducing Z-axis modulation, 27 additional useful display modes are possible. Because the calibrated sweep is generated at a high level, it can be fed directly into the horizontal deflection plates without amplification. Therefore, it is possible to use one gun of the dual-beam cathode-ray tube as a single beam oscilloscope having identical amplifiers, each amplifier having one millivolt full-scale sensitivity, while either the x or y input of this display can be simultaneously presented against time on the other channel. **Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N.J.**

Ceramic Disc Replaces Iron-Core Magnet . . .

Feather-weight radio loud speakers are now possible with the development of an electrostrictive ceramic. Baked in the form of thin discs a few thousandths of an inch thick, these barium titanate ceramics respond to minute and rapid fluctuations in electrostatic fields. Bonded to a larger titanium disc they produce a cupping action that in turn drives a speaker cone. No modification in the radio circuitry is needed to adapt it to the ceramic loudspeaker. **Electric Machinery Mfg. Co., Mullenbach Div., 2100 E. 27 St., Los Angeles 54, Calif.**

Digital Flow Indicator . . .

Based on a servo null-balance design, this indicator presents digital data directly in units of flow. A specific gravity correction control quickly adjusts for direct readout in pounds per hour. Where liquids have a varying specific gravity, special equipment is available for continuous automatic correction. **Performance Measurements Co., 15301 W. McNichols, Detroit 35, Mich.**

Transistorized Valve Control . . .

The amplifier-relay portion of this control uses two transistors with a printed circuit to produce a compact motor operated valve control. **Barber-Colman Co., Dept. 59 Directory, 1856 Rock St., Rockford, Ill.**

Just the

TICKET
THE A-MP TOOL AND TERMINAL TEAM
—a one man production line
Rates can go as high as three or four thousand finished terminations per hour. Reliability is the highest, most uniform in the world.
EQUALLY IMPORTANT:
This is achieved at the lowest installed cost per termination
No matter whether your termination requirements run into the hundreds or the millions, AMP can supply the exact tool and terminal team to cure your cost woes.
AMP

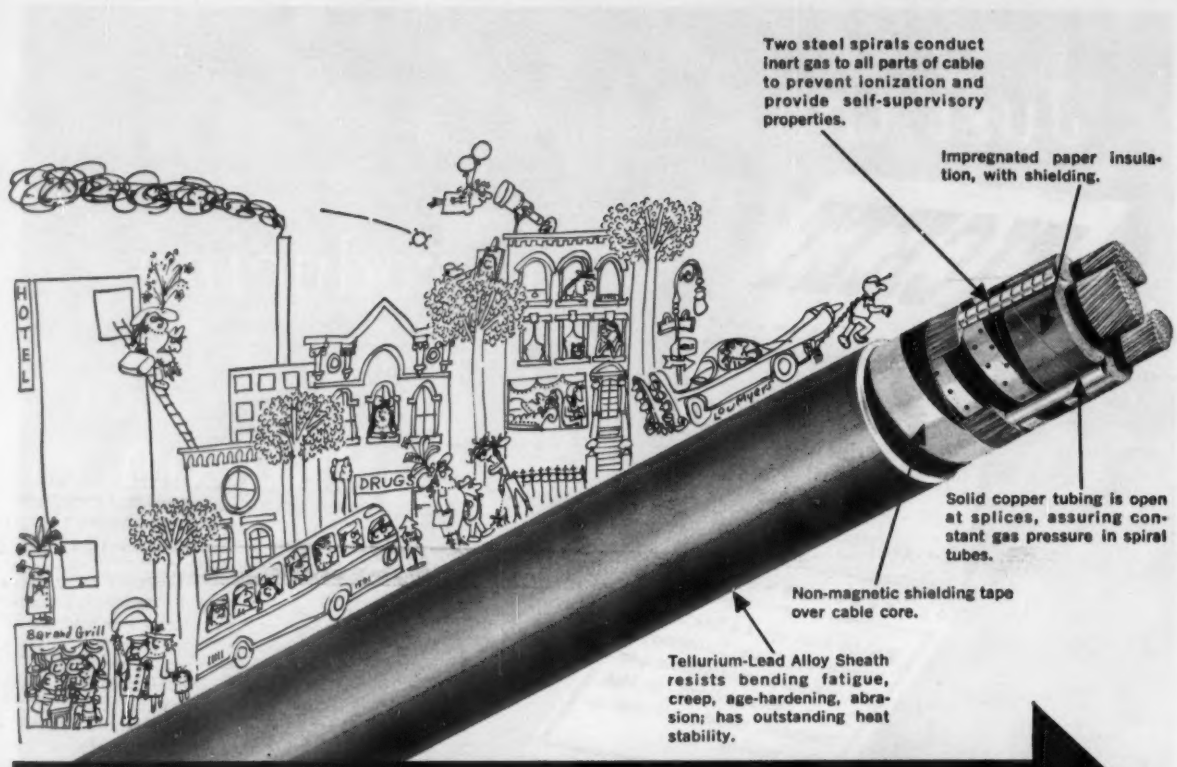
for reducing circuit termination costs.

Send for more cost-saving information today.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan


Two steel spirals conduct inert gas to all parts of cable to prevent ionization and provide self-supervisory properties.
Impregnated paper insulation, with shielding.
Solid copper tubing is open at splices, assuring constant gas pressure in spiral tubes.
Non-magnetic shielding tape over cable core.
Tellurium-Lead Alloy Sheath resists bending fatigue, creep, age-hardening, abrasion; has outstanding heat stability.
HOTEL
DRUGS
Grand Grill

KEEPS UPHILL POWER "ON THE LEVEL"!

ROEBLING
GAS-FILLED CABLE

What happens when solid-type cable is used on steep grades? If you've used it, you know! The oil impregnant simply obeys the law of gravity and drains to the bottom of the grade. At the low point, hoop stress (caused by oil pressure build-up) makes the lead sheath stretch. Eventually a rupture occurs. And in the areas drained of oil, ionization takes place.

What's the answer to this constant (and inevitable) problem? *Roebling Low-Pressure Gas-Filled Cable*—for voltages up to 46 kv! Dry nitrogen gas, inside this cable at approximately 12 psi pressure, provides consistent dielectric properties throughout the length of the cable. No matter how steep the grade, internal pressure is uniform everywhere.

Another feature of this cable is that it is self-supervisory—an alarm system lets you know if there's trouble along the line.

Roebling Low-Pressure Gas-Filled Cable is as easy to splice as solid-type paper power cable. It offers the least expensive long-term answer to the problem of transmitting power uphill! Get the whole story from your Roebling Field Representative soon. Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities • Subsidiary of The Colorado Fuel and Iron Corporation

New ALLEN-BRADLEY OILTIGHT PRESSURE SWITCHES

Bulletin 836 Type T

Both operating pressure and differential are adjustable on these new A-B oiltight pressure switches. Operating pressure is externally adjustable, and setting shows on calibrated scale. A trip indicator shows operating point.

For machine tool hydraulic systems—operating at pressures up to 5,000 psi

Especially designed for heavy duty industrial applications, these new Allen-Bradley oiltight high pressure switches assure long, trouble free life. The attractive die-cast aluminum enclosure is completely sealed to exclude oil and water. The snap-action switch mechanism maintains its high contact pressure to the point of switchover—no matter how slowly it is approached. Contact chatter is eliminated—trouble free contact life is increased. The contact block has two isolated circuits with one N.O. and one N.C. set of contacts.

Send for complete information on this newest addition to Allen-Bradley's wide line of *quality* pilot controls.

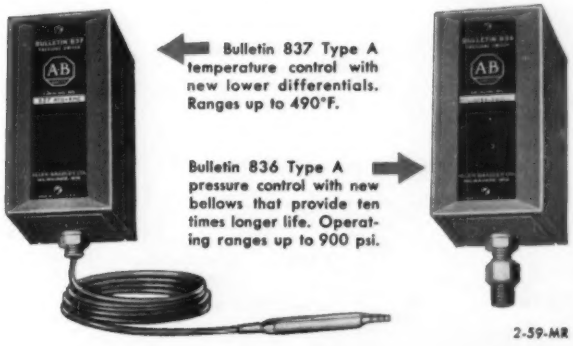
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

A-B QUALITY

Internal view of piston design used on units for systems above 500 psi. Bellows type construction is used up to 500 psi.

Also...A New Line of Pressure and Temperature Controls with Lower Differentials



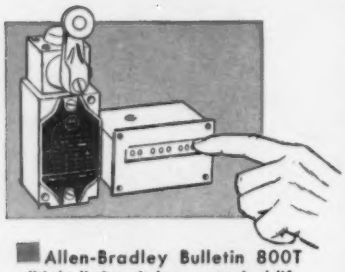
Bulletin 837 Type A temperature control with new lower differentials. Ranges up to 490°F.

Bulletin 836 Type A pressure control with new bellows that provide ten times longer life. Operating ranges up to 900 psi.

2-59-MR

Allen-Bradley is not satisfied until Limit Switch Life runs into

MANY MILLIONS OF OPERATIONS



Allen-Bradley Bulletin 800T oiltight limit switches on typical life tests have run many millions of operations. Write for complete information on the Allen-Bradley line of quality limit switches for every industrial application.

Here are some new—and some old—Allen-Bradley oiltight limit switches—all built to give you extra millions of trouble free operations. Their switch bodies and operating heads are both sealed. Oil, dirt, and metal chips cannot enter and foul the contacts or cause sluggish operation of the momentary contact mechanism. Double break, silver alloy contacts never need maintenance. The snap action switch is positive insurance against any reduction of the contact pressure as the "trip point" is approached. This means less chance for chatter and arcing of relays, contactors, or starters operated by the limit switch—and prolonged trouble free contact life for the limit switch itself.

The Allen-Bradley line of limit switches is complete. Illustrated are only a few variations.

Side Push Rod
Top Push Rod with Plastic Window
Roller Lever for Flush Mounting
Neutral Position Momentary Contact Limit Switch. One set of contacts is closed for each direction of operation.
Adjustable Rod
Adjustable Roller Lever
Wobble Stick Type
Fork Lever Type
Side Push Roller
Roller Lever for Manifold Mounting
Side Push Rod Maintained Contact

2-59-MR

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

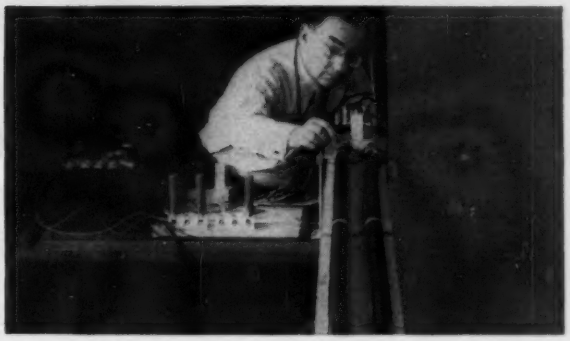
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.

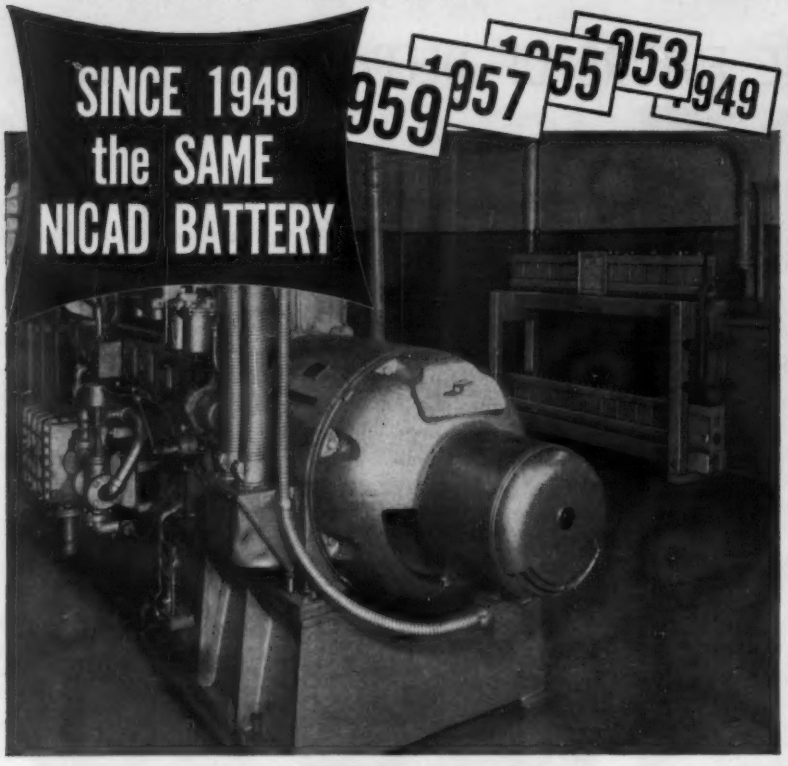


Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

In a power room of the
NEW ENGLAND TELEPHONE & TELEGRAPH COMPANY



has been a RELIABLE SOURCE of engine starting power... at low annual cost

In April, 1949 a NICAD nickel cadmium battery, 32v, 168AH, replaced shorter service life batteries as the starting power source for this large diesel alternator at an exchange building of New England Telephone & Telegraph Co. Twenty-five cells, rated at 1.3v per cell, are connected in series to supply 32v.

And for ten years this NICAD unit has performed perennially "like new"... virtually inspection and maintenance-free.

Deterioration... corrosive fumes... plates that buckle and swell... frequent, costly service... abrupt, unexpected failure—these are the hazards industry avoids by selecting reliable NICAD Batteries for gas and diesel engine starting, supervisory control, emergency lighting, switch tripping, and similar applications.

For more information on NICAD heavy-duty batteries, request Bulletin 200 from NICAD Division, Gould-National Batteries, Inc., Easthampton, Mass.

NICAD
TRADEMARK

NICKEL CADMIUM
ALKALINE
STORAGE BATTERIES

Industrial Notes

(*Continued from page 34A*)

Bell Telephone Laboratories New York, N. Y...

Compression bonding of leads to the metallized germanium surfaces of high-frequency transistors provides a lead structure which can withstand 100,000 g in a centrifuge and very high shocks. Compression bonding is a technique recently developed at Bell Telephone Laboratories,

Courtesy Bell Telephone Labs.

463 West St., New York 14, N. Y. for attaching leads to semiconductors. A combination of heat and pressure is employed to form the bond, but neither is sufficient to cause damage to the semiconductor. When properly formed, bonds made in this fashion can be stronger than the lead itself. This bonding process is highly satisfactory where very small leads must be attached to small areas, as in high-frequency transistors.

Owens-Corning Fiberglas Corp. Toledo, Ohio . . .

An improved Fiberglas appliance insulation which permits increased capacity and thinner walls for refrigerators is now being produced by Owens-Corning Fiberglas Corporation, Toledo 1, Ohio. According to the firm, use of the insulation, designed for refrigerators, water heaters, and ranges, makes possible significant savings in installation as the product is tougher and resists damage during handling. Its increased thermal efficiency permits refrigerator motors to work less while maintaining correct temperatures, resulting in lower operating costs. The new appliance insulation is being manufactured at Owens-Corning plants at Newark, Ohio, Kansas City, Kan., and Barrington, N. J.

Miniature Precision Bearings, Inc. Keene, N. H. . .

Split Ballbearing, a division of Miniature Precision Bearings, Inc., has been constructed at Lebanon, N. H., at a cost of $600,000 to enable the company to manufacture bearings for many new applications in aviation, farm machinery, precision instruments, and other fields. This plant was built in such a way as to allow Split Ballbearing to manufacture the highest quality bearing at the lowest possible cost.

(*Continued on page 52A*)

SERVICE
IN STAINLESS STEEL

"FLIGHT OF PROGRESS"
a stainless steel sculpture by Robert Edward Hamilton

In the past 12 months 91% of all orders for J&L stainless steel bars were shipped, *at least* in part, within 24 hours.

That's service!

The key to such service is a simple one: Complete and balanced inventories at the Mill *and* at strategically located Service Centers only hours from *your* plant or warehouse.

With the most modern flat rolling facilities in the industry now in operation at Louisville, Ohio, J&L is now giving the same service on flat rolled products that fabricators and warehouses have been getting on J&L bars and wire.

Whether you need stainless sheet, strip, bar or wire for your production line or your warehouse customers, *you can get it faster from J&L.*

Plants and Service Centers:
Los Angeles • Kenilworth (N. J.) • Youngstown • Louisville (Ohio) • Indianapolis • Detroit

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SHEET • STRIP • BAR • WIRE

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Box 4606, Detroit 34

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Will perform electrical engineering and consulting services required in the protection, control and instrumentation of electric systems and related facilities. Must be thoroughly acquainted with all phases of modern relaying practices, switchgear applications, short circuit studies, system performance calculations, lightning arrester coordination, communications and telemetering.

This is an excellent opportunity for a graduate EE with 10-15 years' electric utility company experience.

Send complete resume including salary desired to:

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33 W. 39th St.
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New York 18, N. Y.

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Trade Literature...

Image Converter Camera Brochure . . .

Details of an ultrahigh-speed image converter camera are given in a 2-page publication. The camera is designed around a newly developed image converter tube, electrostatically focused and deflected, and is intended for the study and photographic recording of transient phenomena in the microsecond range. Details of synchronization, exposure times of 0.05 to 1.0 microseconds, and frame spacing of 0.5 to 50 microseconds are discussed. **Applications Engineering, Precision Technology Department, Librascope, Inc., 66 South P St., Livermore, Calif.**

Movie on Photo Reproduction Techniques . . .

Produced for showing to industrial, business, and professional groups, particularly engineering management, the movie "Photo-Reproduction" illustrates how large and small organizations can boost efficiency and cut drafting costs by putting photoreproduction to work. From reclamation of illegible originals to cut-and-insert work on photographic engineering intermediates, which can trim a week's drafting job to eight hours, the 23-minute color movie accents potential savings. Industrial, business, and professional groups or individuals may borrow copies of "Photo-Reproduction" for showing by writing: **Graphic Reproduction Division, Eastman Kodak Co., Rochester 4, N. Y.**

"Hastelloy" alloy F . . .

Stress corrosion cracking, a long-standing problem in the chemical field, has been brought under control by use of a nickel-base alloy, subject of a 12-page booklet, which lists physical, chemical, and mechanical properties, and other valuable data. Hastelloy alloy *F* is a product of **Haynes Stellite Co., Division of Union Carbide Corp., Kokomo, Ind.**

Guide for RFI Shielding . . .

Comprehensive technical data and product information on radio frequency interference gasketing are available in a handy RFI Designers Data File, prepared to help designers solve specific shielding problems, with both technical data and practical information about RFI gasketing materials. **Technical Wire Products, Inc., 48 Brown Ave., Springfield, N. J.**

Insulation for Electrical Heating . . .

"How to Insulate for Electric Heating" a 23-minute, full-color, sound-slide film, illustrates recommended thicknesses and proper methods of installing insulation in ceilings, walls, and floors. Also discussed are condensation problems, venting requirements, and the insulation of existing houses. **Owens-Corning Fiberglas Corp., Dept. 54, Toledo 1, Ohio.**

Time and Cost Record Book . . .

In this special 24-page monthly time and cost record book, 12 sets of pages are included on which to record, day by day, each month's individual machine expenses for an entire year. At the end of the record section is an annual summary sheet where the totals for each month can be entered to obtain annual cost figures. At the end of each month the columns may be totaled to determine expenses for that particular month. To help compute owning and operating costs, a section at the back of the book explains simple methods of calculation. In order to record expenses as they occur in the field, a pocket size daily time and cost record booklet is also available. This booklet can be used for recording time and expenses as they occur. Periodically, these figures may be transferred from the daily to the monthly cost record book. Copies of the "Monthly Time and Cost Record Book," Form *33215*, and "Daily Time and Cost Record Booklet," Form *32818-G* can be obtained free from Caterpillar dealers requesting publications by title and form number from the Advertising Division of **Caterpillar Tractor Co., Peoria, Ill.**

Transformer Catalog . . .

A 24-page catalog titled "Pulse Transformers" and designed to assist engineers in the application of transformers to their specific needs, complete with many tables, charts, and schematics covers a brief history of low-level pulse transformers, their measurements, specifications, applications, interchangeability, dielectric ratings, manufacturing, and other data. **PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.**

Nickel-Cadmium Storage Batteries Bulletin . . .

Bulletin *200* assists architects and engineers in their selection of heavy-duty nickel-cadmium storage batteries for industrial engine starting and stand-by power applications. The illustrated 4-page 2-color bulletin provides detailed selection data on Nicad batteries designed for starting diesel and gasoline engines, supervisory control, emergency lighting, and switch tripping. **NICAD Division, Gould-National Batteries, Inc., Easthampton, Mass.**

(Continued on page 54A)

NLS 481 Simplifies and Accelerates Power Supply Testing

Many manufacturers are finding that power supply testing is greatly accelerated by the NLS 481 Digital Voltmeter. During regulation tests, changes of 0.01% in output voltages are measured and displayed *instantly* . . . in one-tenth of the time required by manually-operated instruments! As the voltage changes, the 1-inch numerals change on the easy-to-read illuminated readout.

With 10 Megohm input impedance and a range of 0.001 to 1000 volts, the NLS 481 also is being used for precise measurement of Zener diodes.

The NLS 481 is easily operated by unskilled personnel . . . by anyone who can read numbers. Range change, decimal placement, and polarity indication are performed automatically by the instrument. And no special preparation is required. Connect the cable, snap on the switch . . . the instrument is ready to go to work!

MAKE YOUR OWN TEST

Even though the NLS 481 is the least expensive of 4-digit voltmeters, competitive life tests reveal it will outlast other makes costing two to three times as much. You are invited to *make your own life and performance tests* without obligation. Phone or wire today and we will supply you with an NLS 481 for this purpose. Then you can see for yourself why the NLS 481 is finding ready acceptance in the areas of quality control, electronic design, field testing, and research.

NLS 781 DIGITAL OHMMETER

Providing the same basic operational features as the NLS 481, the NLS 781 Digital Ohmmeter sells for the same low price. With a range of 0.1 ohm to 10 Megohms, the NLS 781 is proving particularly useful for rapid inspection of precision resistors.

The price below is for either the NLS 481 or NLS 781:

FURNISHED COMPLETE $1285 • F.O.B. SAN DIEGO

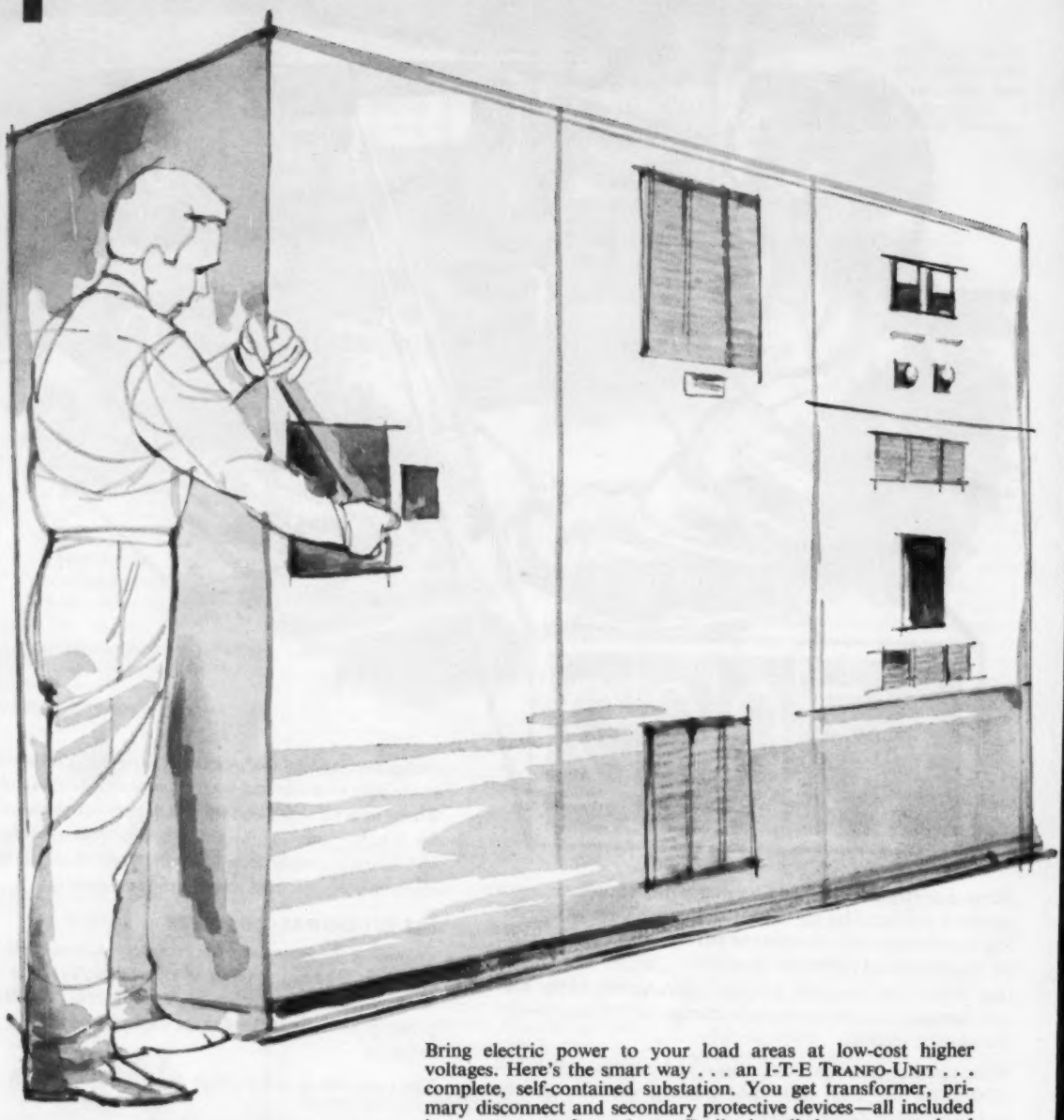
Originators of the Digital Voltmeter

non-linear systems, inc. DEL MAR (San Diego), CALIFORNIA

1959 IRE SHOW — Booths 3041-2

NLS—The Digital Voltmeter That Works...And Works...And Works!

I-T-E CIRCUIT BREAKER COMPANY

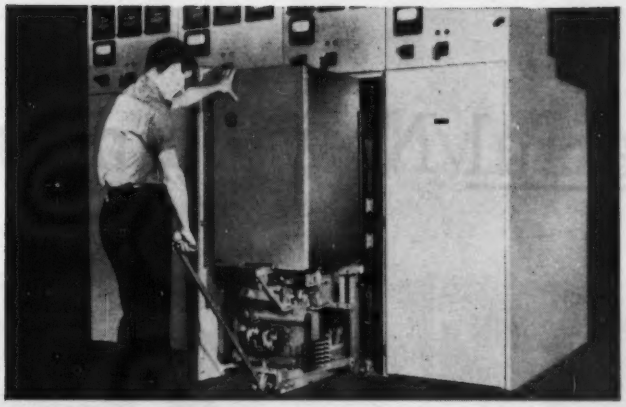


SMART

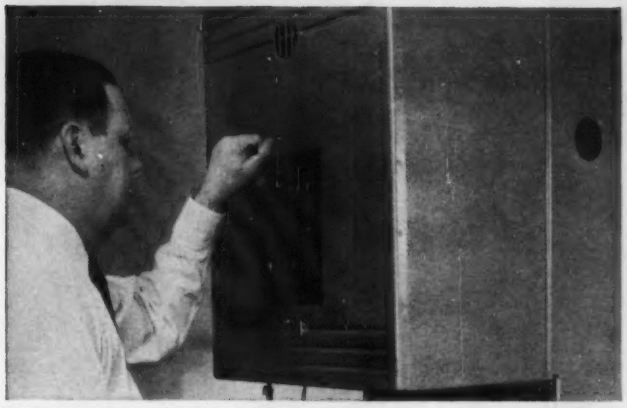
Bring electric power to your load areas at low-cost higher voltages. Here's the smart way . . . an I-T-E TRANFO-UNIT . . . complete, self-contained substation. You get transformer, primary disconnect and secondary protective devices—all included in one neat, safe package. Easily installed near your load centers. Improves motor performance and lighting efficiency . . . slashes line losses.

An I-T-E TRANFO-UNIT costs no more than hodgepodge arrangements of assorted gear. But it looks so much better. It's safer. And it makes possible significant economies. For example, it's delivered in one piece . . . saving installation expense. Wide choice of components means complete design flexibility. So you can meet your own requirements exactly. Available in the industry's widest range of kva ratings.

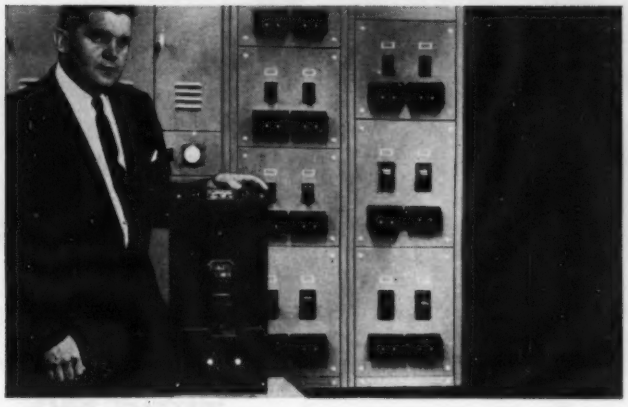
Applications for which an I-T-E TRANFO-UNIT is particularly suited include: small industrial loads, warehouses, hospitals, schools, office and commercial buildings. When you install electrical equipment for such uses, benefit from the advantages of the I-T-E TRANFO-UNIT. They are typical of the advantages you get in all I-T-E equipment. Yet when you buy I-T-E, you pay no more. Why buy anything else?



Metal-clad switchgear you can be proud of. Extra sturdiness for longer life. Extra craftsmanship for finer appearance. Extra safety for greater personnel protection. All components completely accessible. Even rear doors are hinged. Advanced design, uniform-flux-density coils mean extra protection against heavy current faults.



600 volt value package. New URELITE® individually enclosed I-T-E K-line circuit breaker—world's most advanced. Main disconnect contacts visible through side window for extra safety. Pull-down handle action provides quick manual make for safety and long contact life. New wide-range overcurrent trip device lets you increase breaker setting when your load increases. No parts to replace.



Saves 50% switchboard space. I-T-E CORDON® circuit breaker provides up to 100,000 amp interrupting capacity with molded case construction. Costs approximately ⅓ less than alternative devices. Available in sizes for many applications, loose or individually enclosed.

I-T-E Circuit Breaker Company
1900 Hamilton St., Phila. 30, Pa.

- ☐ Low voltage switchgear
- ☐ Metal-clad switchgear (5 and 15 kv)
- ☐ Secondary unit substations
- ☐ Outdoor substation structures
- ☐ TRANFO-UNITS
- ☐ URELITE circuit breakers
- ☐ Small air circuit breakers
- ☐ CORDON circuit breakers
- ☐ Power switching centers

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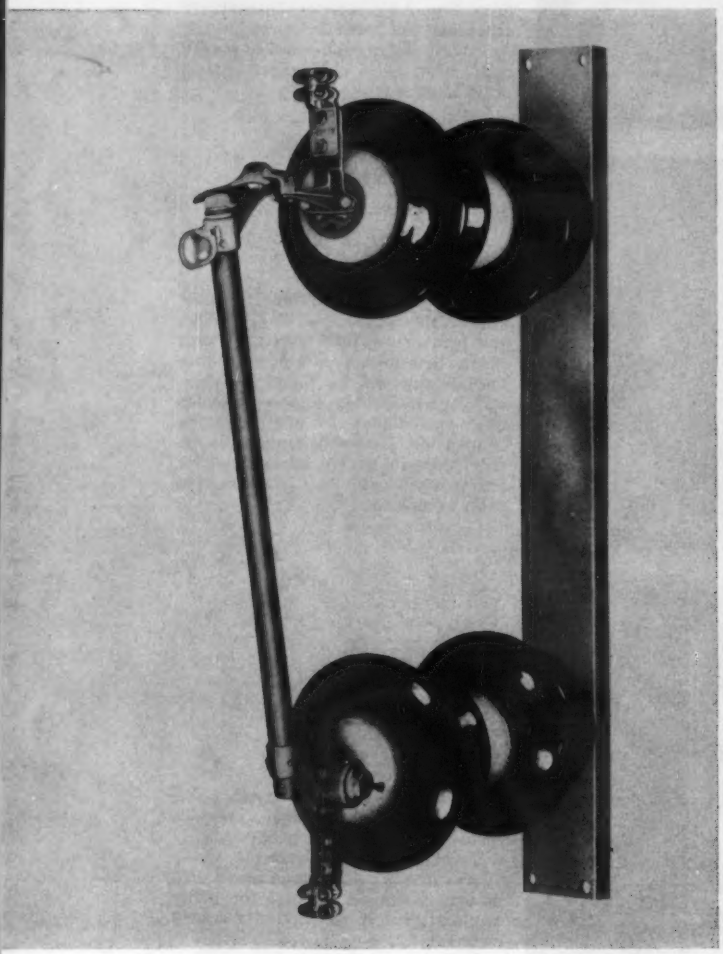
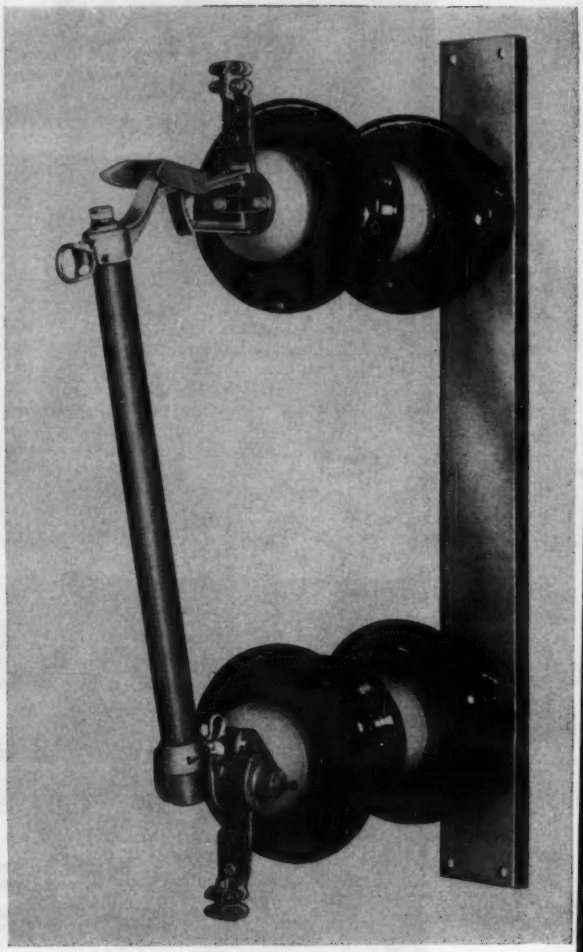
Get full details on specific I-T-E equipment. I-T-E engineering assistance is at your disposal.

A Powerful New Family of





TYPE BP

7.5 kv to 69 kv—100 and 200 amps

This heavy duty power fuse is ideally suited for economical system protection when interrupting capacities range no higher than 1,491,000 kva.

TYPE MP

46 kv to 161 kv—100 and 200 amps

This extra heavy duty power fuse is the huskiest of the Southern States line, with interrupting ratings as high as 3,480,000 kva. A real brute!

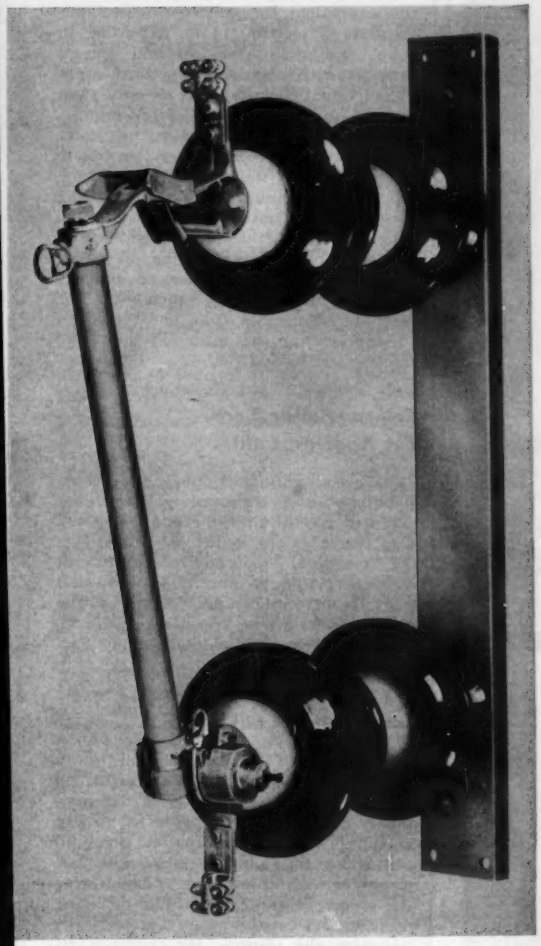
PIONEERS IN POWER FUSES SINCE 1924

SOUTHERN STATES EQUIPMENT CORP.

HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

Power Fuses by Southern States



TYPE HP

7.5 kv to 69 kv—300 and 400 amps

This extra heavy duty fuse is especially suited for applications requiring a combination of high continuous current and interrupting ratings.

COMPLETE FUSE KITS AVAILABLE

These economical kits, in clearly marked packages, provide field personnel with *all the components necessary* for quick, easy re-fusing. They are available in four speed ratios to meet all requirements. Contents are sealed in moisture-free polyethylene bags.

• HIGHEST INTERRUPTING RATINGS

Up to 785,000 kva at 23 kv—
2,350,000 at 69 kv—3,480,000 at 161 kv

• LOWEST INITIAL AND RE-FUSING COSTS

• WIDEST RANGE OF SELECTIONS

Here is the greatest development in power fuses in years! It comes at a time when higher system faults and complex load conditions call for greater reliability in system protective devices.

Southern States Power Fuses can be used with full assurance of positive interruption in the complete range of fault currents—from the lowest that will melt the current-responsive element to the worst jolt the system can deliver!

The fuses employ a new fuse holder design and rugged fibreglass* fuse tubes to clear faults at values never before thought possible.

For example, look at these representative ratings:

TYPE	KV	KVA 3 phase symmetrical
BP	7.5	162,000
BP	15	406,000
BP	23	785,000
BP	34.5	1,175,000
MP	46	1,988,000
MP	69	2,350,000
MP	115	3,110,000
MP	138	2,980,000
MP	161	3,480,000

Find out how these new Southern States Power Fuses can be used on your system—to provide greater protection at lower cost. See your Southern States representative, or

WRITE FOR NEW TECHNICAL BULLETIN 59PF

SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

**For economy and where duty requirements are not excessively high, fuse tubes of NEMA grade XX bakelite are available below 46 kv at lower prices.*

SHAWMUT'S TIME-TESTED SILVER-PLATED

Tri-onic (Dual-Element)

The General Purpose Fuse

*Interrupting Capacity 25,000 Amps. A.C.

KEEPS MOTOR CIRCUITS SAFE

This is the first low voltage fuse with a published interrupting capacity of 25,000 Amps. (15,000 Amps. more than required by U.L. Standard for fuses.) For real protection use it in place of all ordinary types of fuses.

TRI-ON(IC*) GIVES 3-WAY PROTECTION

1. **HIGHER INTERRUPTING CAPACITY.** 25,000 A. @ 250 V & 600 V. Handles short-circuits 2½ times larger than ordinary fuses. Expands fuse application into 25,000 Amp. zone. Use it on bus plug-in duct, bus-ways, feeders, motor control panels, branch circuits.
2. **LONG TIME-DELAY.** Safely starts heavily loaded motors without blowing. Prevents circuit "outage" caused by heavy motor-starting currents or load swings. Provides "matched" protection for your motors.
3. **COOLER OPERATION.** Runs cool because of silver-plating and low I^2R losses throughout. Opens at 286° F, or 500° lower than ordinary zinc links. Ideal for distribution and panel boards, motor branch circuits, knife and enclosed switches.

* U.S. Patent Nos. 2,111,749 – 2,300,620 2,321,711

Insist on TRI-ONIC. Ask for TRI-ONIC Bulletin today.

© The Chase Shawmut Co. 1958

Tri-onic – "Awake At The Switch"

THE CHASE-SHAWMUT CO.

374 MERRIMAC STREET • NEWBURYPORT, MASSACHUSETTS

Subsidiary of I-T-E CIRCUIT BREAKER CO., Philadelphia, Pennsylvania

Est. 1893

Industrial Notes

(*Continued from page 44A*)

RCA Electron Tube Division Harrison, N. J. . .

A multiple-function tube testing machine which can test up to 2,500 electron tubes per hour has been developed by the RCA Electron Tube Division, 415 S. 5th St., Harrison, N. J. The company will offer the equipment for sale to other manufacturers of electron tubes. According to D. Y. Smith, vice-president and general manager, each machine can perform up to 15 individual electrical tests on more than 40 miniature receiving tubes per minute. A unique feature of the factory tube tester is a system of programming that establishes the test criteria for different tube types. Programming boards, containing a maze of spaghetti-like wires, can be plugged into the device in less than a minute. These boards can be preset according to the testing schedule and are interchangeable within themselves. A complete changeover from one tube type to another can be made in about 20 minutes.

Telecomputing Corp. Los Angeles, Calif. . .

To add additional missile systems capabilities to Telecomputing Corp., the company has acquired the Frank R. Cook Co., Denver, Colo., which is well known for its original design and manufacture of high-energy power sources for air- and space-borne applications. Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Calif.

Thompson Ramo Wooldridge Inc. Los Angeles, Calif. . .

Monsanto Chemical Co. will put a computer-controlled chemical plant on stream during 1959. By use of the computer, the company expects to achieve maximum productivity from its plant investment at minimum operating cost. The computer will achieve this by monitoring the process conditions continually making numerous calculations, and automatically adjusting the controls for optimum results. The computer installation will be the result of a joint study by Monsanto's systems engineering group and The Thompson-Ramo-Wooldridge Products Co., a division of Thompson Ramo Wooldridge Inc., P. O. Box 90067, Airport Station, Los Angeles 45, Calif.

A. B. Chance Co. Centralia, Mo. . .

The High-Voltage Division of Porcelain Products, Inc. has merged with the A. B. Chance Co. Porcelain Products has been operated as an A. B. Chance Co. subsidiary for the past few years; its Low-Voltage Division in Carey, Ohio, will continue to operate as a division with a separate marketing organization.

CLASSIFIED ADVERTISING

For help and situations wanted, $2.25 per line, minimum 5 lines, maximum 30 lines. Sale and purchase of used machinery, etc., $3.00 per line, not available to dealers. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y., unless other address is given.

Positions Open

SCIENCE AND ENGINEERING AT ROBERT COLLEGE OF ISTANBUL. Opportunities at Robert College in Istanbul, Turkey, for qualified men in engineering, mathematics, physics and chemistry interested in combining teaching and consulting with the opportunity to live and travel in a vital part of the world. Development program is in effect to strengthen staff, modernize undergraduate curricula, inaugurate graduate program, construct new science and engineering building, prepare engineers for the industrial and technological development of Turkey and the Middle East. A challenging work with far-reaching possibilities. Address inquiries to Dr. Duncan S. Ballantine, President, or Dean Howard P. Hall of the College of Engineering at Robert College, Bebek P. K. 8, Istanbul, Turkey, with copy to the Near East College Association, 40 Worth St., New York 13, N. Y.

ASSOCIATE OR PROFESSOR OF ELECTRICAL ENGINEERING to teach undergraduate courses in communications and part time research. To twelve thousand for eleven months. Ph.D. degree. Dean of Engineering, University of Santa Clara, Santa Clara, California.

CHIEF ENGINEER, 44000KW Steam Generating plant now under construction. Sea Coast, Southern Peru, the applicant must be capable of taking responsibility for Operation and Maintenance. Should have five to ten or more years central station experience. For details as to salary, living conditions, contact Mr. John L. Splane, 410 Arizona Land Title Building, Tucson 1, Arizona.

TEACHERS NEEDED for permanent staff in an expanding department. Salaries depending on experience and academic background. Write to Electrical Engineering Department, Louisiana State University, Baton Rouge, Louisiana.

ELECTRONIC ENGINEER MSEE or BSEE, with 2-3 years' experience in instrumentation and control design or related fields. To work in group developing measurement and control devices for steel industry processes. Location in modern laboratory in suburban Pittsburgh. Send resume to J. A. Hill, Research & Development Department JONES & LAUGHLIN STEEL CORPORATION, #3 Gateway Center, Pittsburgh 30, Pennsylvania.

GRADUATE ASSISTANTSHIPS are available at a university in the Southeast for September 1959. Assistants may obtain the Master of Science degree in Electrical Engineering in twelve months. Tuition free. Box 654.

ENGINEER FOR DESIGN, development and testing compression fittings for power lines. BSME or BSEE. Experience in design and construction of transmission and distribution helpful, but will consider recent graduate. Good fringe benefits. North West Chicago suburb. Salary open. RELIABLE ELECTRIC COMPANY, 11333 Addison Street, Franklin Park, Illinois.

RESEARCH AND DEVELOPMENT—openings for electrical engineers interested in the design and development of electronic and electromechanical devices for industrial clients. Degree in electrical engineering or physics required. Industrial experience helpful. Please send resume to Mr. John C. Stowe, Arthur D. Little, Inc., 35 Acorn Park, Cambridge 40, Massachusetts.

INDUSTRIAL CONSULTING—opening for an electrical engineer interested in market research, primarily for the electronics industry. Experience in industry and/or M.B.A. required. Please send resume to Mr. John C. Stowe, Arthur D. Little, Inc., 35 Acorn Park, Cambridge 40, Massachusetts.

(Continued on page 70A)

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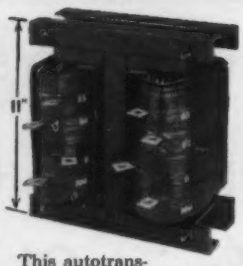
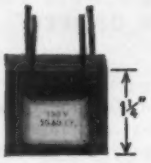


This autotransformer is used for reduced-voltage starting of synchronous and induction motors. 50, 65 and 80 percent taps are normally provided. Terminals may be mounted on the coil or leads.



Low-voltage pilot light transformers up to 600 V primary.

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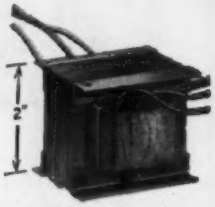

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Wisconsin 7-0727

Trade Literature

(*Continued from page 46A*)

"Sone" Rating Slide Rule Calculator . . .

Acoustical engineers have recently developed the "sone" rating system, which not only rates the sound pressure level but also takes into account the effect of frequency on the human ear. This single-figure numerical rating can now be manipulated as easily as kilowatts in the design of industrial and commercial buildings. Truly relative terms are now available under which 10 sones is twice as loud as 5 sones and half as loud as 20 sones. The system is recommended for all manufacturers of noise-producing equipment. With a slide rule calculator, the calculations are simple and rapid. Obviously a benefit to fan users, the calculator can also be used for other equipment having a noise spectrum similar to that of most rooms and a known sone rating. Calculators are available at no charge when requested on company letterhead from **Propellair Division, Robbins & Myers, Inc., 1934 Clark Blvd., Springfield, Ohio.**

Microwave Standards Prospectus . . .

A 36-page application note describing the latest techniques and instrumentation for making various microwave standards measurements presents a detailed description of the techniques used in the general areas of standards measurement, including frequency, attenuation, impedance, and power. "Microwave Standards Prospectus" contains typical measuring arrangements with many system block diagrams and accuracy curves. Write Ron Whitburn, **Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.**

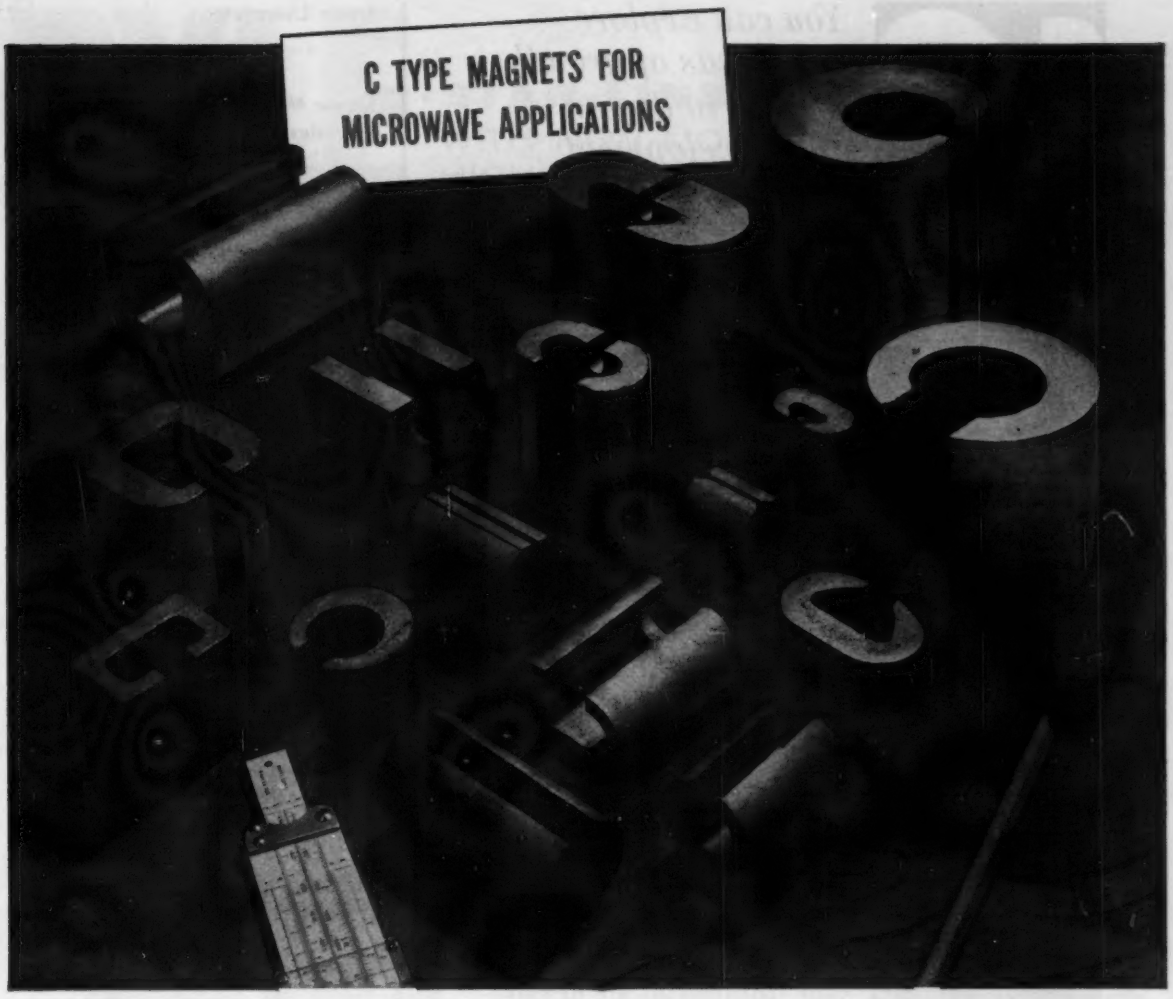
Tubing Brochure . . .

"The Measure of Tubemanship" has been published to further acquaint industry with the combination of skills and techniques that are necessary to the manufacture of seamless copper and copper alloy tubing. Features included in the publication are Wolverine Tube's modern facilities, the components of Tubemanship, complete quality control through the various stages of production, creatively in developing new ideas and products, and related customer services. **Wolverine Tube, Division of Calumet & Hecla, Inc., 17200 Southfield Rd., Allen Park, Mich.**

Three-Stage Forming Machine Bulletin . . .

A bulletin on the Rotary-Vac 3-stage forming machine for plastic vacuum forming, said by the manufacturer to be the fastest sheet-fed thermoforming machine, is available from **Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.**

(*Continued on page 56A*)



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Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

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Trade Literature

(*Continued from page 54A*)

Singer Military Facilities Booklet . . .

Its facilities for service to the Armed Forces and their prime contractors are described in a 28-page booklet issued by The Singer Manufacturing Co. The booklet shows how the Military Products Division functions in such diverse areas as operations and systems research, electronic and electromechanical systems, radar relay and infrared reconnaissance systems, electronic computers, low-inertia servomotors, servomotor systems, high precision electromechanical timers, and hermetically sealed high-voltage switches. Special emphasis is laid on thorough testing and quality control and on the financial responsibility provided by the parent organization. **Singer Manufacturing Co., Military Products Division, 149 Broadway, New York 6, N. Y.**

Standards Brochure . . .

"What Is a Standard?" is the title of a free brochure now available. The text explains the nature of standards and of American Standards. Also described are the functions of the American Standards Association as the national clearinghouse for standardization in the United States and as the representative of American interests in international standards work. **American Standards Association, Dept. PR 34, 70 E. 45th St., New York 17, N. Y.**

Microwave Standards Measurements Prospectus . . .

A 36-page application note describing the latest techniques and instrumentation for making various microwave standards measurements presents a detailed description of the techniques used in the general areas of standards measurement, including frequency, attenuation, impedance, and power. Write to Ron Whitburn, **Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.**

Basic Reference for Missile Designers . . .

Created specifically to meet the informational needs of designers, Silicones in Missile Design (Code 1-131) covers the use of silicones to aid miniaturization and weight reduction, and to increase the reliability of missiles and missile components; it is well organized for quick reference to the many missile and rocket applications for silicone rubbers, resins, dielectrics, fluids, greases, and compounds. **Dow Corning Corp., Midland, Mich.**

"Modern Force Measurement" . . .

A semitechnical booklet on modern industrial techniques for measuring force, weight, pressure, etc., is now offered by the **Electronics & Instrumentation Division, Baldwin-Lima-Hamilton, Waltham, Mass.**

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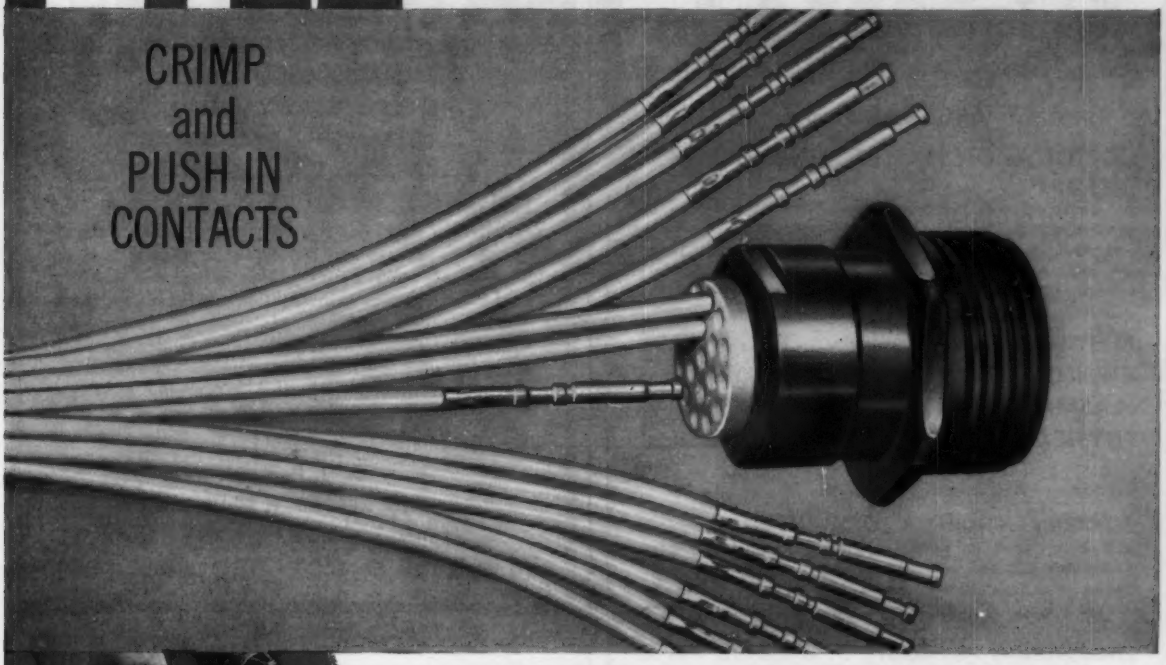
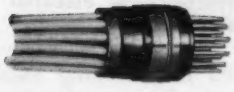
WITH NEW MOD. 2 INSERTS FOR HIGH-SPEED, RELIABLE TERMINATION





Mod. 2 Insert, 19-Pole
with metal housing removed

1. Individual contacts are crimped to wires outside connector by a semi-automatic tool, then, for assembly, inserted one by one into insulation with crimped joint intact.

2. Contact retention ability of resilient insulation exceeds the requirements of MIL C-5015-D even after many reassemblies.

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4. Simplicity of wire termination greatly reduces errors in circuitry. Changes in circuitry are simple and speedy.

5. Up to 100 poles for wires sizes 16, 12 or 10, with no sacrifice in environmental resistance, or ability to meet and exceed MIL C-5015-D in Class A, B, C, E and R.

6. *Two-piece Mod. 2 insert* is interchangeable within Standard Pyle-Star-Line barrel shells with *three-piece Mod. 1 insert.*
Mod. 1 inserts for wire sizes up to 4/0 are available for disconnect and for current rupturing service.

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Temperature	—80 F. to 225 F.
Pressure	300 PSI External, 200 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015D
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015D
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015D
Air Leakage	Meet Class E Spec. of Mil C-5015D

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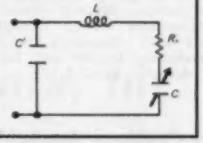
Package (actual size)	C'	C @ zero bias (nominal)	cutoff frequency* (nominal)	L (nominal)	V_B** Min.	V_B** Nom.	Equivalent Circuit
HPA 2800	0.1$\mu\mu$f	2.5$\mu\mu$f	70KMC	4mμh @ 1KMC	5V	7V	
HPA 2810	0.2$\mu\mu$f						

*At breakdown voltage **Breakdown voltage (10μA point)

CAPACITANCE vs. BIAS VOLTAGE	Reverse Bias Voltage	Capacitance C
	0 V	2.5 $\mu\mu$f
	3 V	0.76 $\mu\mu$f
	7 V	0.60 $\mu\mu$f

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Men Available

Elec Engr, Diploma Engr, 32; 11 yrs exper. Power station control; design of transmission lines; design of overall industrial systems for oil and chemical plants, relay and short circuit studies, field exper, customer liaison, etc. Location desired: Overseas. E-123.

Sales or Engrg Exec, B.S. in M.E., B.S. in E.E., M.S., 46. Broad sales and engrg exper in heavy industry, mill machinery and electrical, and metal industry operations. Location desired: Anywhere in U.S. or abroad. E-124.

Elec Engr, B.S.E.E., B.B.A., B.S., 33 6 yrs exper as production engr in heavy transportation equipment, and electronic components. Have good all around industrial background and management potential. Location desired: West Coast preferred. E-125.

Relay Application (design or sales) Engr, Switch Gear Engr, 40, protective relay application, design and sales engr—3 yrs. Location desired: New York or East. E-126.

Elec Engr, B.S.E.E., M.S.I.E., 35 Registration 10 yrs chemical, petroleum, utility, plant experience in application, construction, design, maintenance, test project. Individual, staff and supervision responsibility. E-127.

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Plt Engr, B.S.E.E., 29. 6 yrs induction motor application, design, project engr and proposition, requisition, factory contact, complaint, cost improvement service Considerable exper in contact with customers, vendors, management, marketing people and factory workers. Location desired: East. E-129.

Positions Available

Associate and Assistant Professors for department of electrical engineering. Rank of Associate Professor requires Ph.D. degree; Assistant, Master's degree. Location, South. W-6887.

Electronic Engineers. (a) Electronic Engineer, Junior or Senior, Pulse and Video, graduate electrical, with three to five years' experience in pulse and video system work. Will be responsible for project assignments in development of complex systems which include analog computers as well as video equipment. (b) Electronic Engineer, Servo Systems, with three to five years' experience in servos and analog computers. Will develop miniature servo systems using sub-miniature vacuum tube circuitry and transistorized circuitry; develop computer assemblies comprised of resolver linear transformers and other rotary components. Salaries, $8000-$11,000 a year. Company pays placement fees. Location, Long Island, New York. W-6890.

Sales and Application Engineer, graduate electrical, with a minimum of five years' experience with a manufacturer of heavy electrical equipment. Should be conversant with electric drives and controls used in the steel, chemical, rubber, paper and other industries. Location, New York, N. Y. W-6903.

Research Engineer, electronics, minimum of Bachelor's degree, Master's or Doctor's degree preferable, research experience may take the place of advanced degree. Should have strong interest in electronics research and should be able to initiate and conduct research activities with a minimum of supervision. Salary, about $8000 a year. Location, South. W-6907.

Associate Director of Research, Ph.D., preferably in physics or electrical engineering, and would have a combined career including possibly both industry and education. Will evaluate the present or contemplated programs in research which may be established. Salary open. Location, New York State. W-6917.

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Assistant or Associate Professor for department of electrical engineering, of a university. Ph.D. required. Location, East. W-6955.

Telephone Transmission Engineers, M.S. in electrical engineering, with five to ten years' experience, for a public utility. Location, South W-6960.

Assistant Design Engineer for consulting engineering services, for work in the electric utility field and in industrial facilities planning and engineering; some experience in these areas desired. Should be registerd or working toward registration. Some traveling necessary to obtain data and supervise field projects. Foreign assignment may be involved at some time. Salary, to start, $5400-$7?00 a year. Location, Colorado. W-6969.

Systems Engineers. (a) Systems Engineer Supervisor for basic hydraulic research; M.S. or Ph.D. in electrical or mechanical engineering, with graduate work concentrated on servomechanisms as applied to advance type system designs relating to computer systems or guidance systems design and analysis; must have good knowledge of hydraulic, pneumatic, electrical and mechanical engineering principles. Under direction, will be responsible for the design, redesign, layout and analysis of complete hydraulic systems. Accent on this position is on practical and administrative experience. Salary, $15,000-$18,000 a year. (b) Systems Engineer, Theoretical, for basic hydraulics research, educational and experience requirements similar to above, except that only three to five years' experience is required. Accent on this position will be on the theoretical. Salary, $12,000-$15,000 a year. Location, Ohio. W-6981.

Sales Engineer, Hydraulics, graduate electrical or mechanical, with strong interest in the area of control systems; at least two years' engineering development work, preferably in the areas of hydraulics and electronics; at least three years' sales experience, preferably with a firm marketing hydraulic and electronic products or services. Will represent small consulting research group to obtain hydraulic research contracts. Salary, $9600-$10,800 a year. Location, Massachusetts. W-6984.

Applications Engineer, graduate electrical or mechanical, preferably one or two years' in the precision instrument or bearings fields, or in the design and development of rotating equipment. Under direction, will perform highly technical engineering duties primarily related to the design and application of small high precision ball bearings; assist in computing performance, application and design data, etc. Salary, to start, $5500-$7000 a year depending upon education, experience, potential. Location, New England. W-6998.

Regional Sales Manager, graduate in mechanical, electrical, or aeronautical engineering, with five to ten years' experience in a similar position. Will supervise one to fifteen field engineers selling technical aircraft and missile control components and systems; will be responsible for preparation and adherence to sales forecasts and sales operating budgets for volume of three to six million dollars; prepare and coordinate component and system proposals. Customers will include the military service, prime and major subcontractors as well as commercial airframe and subcontractors. Salary, $14,000-$16,000 a year, plus sales and corporate profit incentive including generous fringe benefits. Territory, Eastern Region; headquarters, New York, N. Y. W-7004.

Senior Project Electronic Engineers, graduates, to take over electronic component part design, either on delay lines, filters, magnetic amplifiers or pulse transformers. Salary, $9000-$12,500 a year. Location, upper New York State. W-7009 (b).

Electrical Engineer, power option, Ph.D. preferred; teach and research duties. Rank and salary commensurate with qualifications and experience. Location, eastern Canada. F-7013(a).

Systems Engineer, degree in mechanical or electrical engineering, or physics, with experience in the analysis of system concepts; some familiarity with aircraft environmental control systems or extensive laboratory experience on system controls. Will involve study and evaluation of new and novel air conditioning systems; must be familiar with heat transfer, fluid flow and controls. Salary, $7500-$9000 a year. Location, New York State. W-7016.

(Continued on page 62A)

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For Details, write Mr. C. J. Blades, Manager, Professional Employment, Dept. 206A, Burroughs Corporation ElectroData Division, 460 Sierra Madre Villa, Pasadena, California.

PENNSYLVANIA at our Research Center near Philadelphia

Systems Engineers with specific experience in systems analysis and design of digital data processors. Should be trained in engineering, physics or mathematics. Graduate training desirable.

Mathematicians, computer-oriented, with particular experience in problem formulation, numerical analysis, and applied mathematics—in connection with formulation and design of computational procedures. Procedures involved in problems of guidance and air defense, trajectory calculations, logical design, sampled data systems, circuit analysis and more. Advanced degree in mathematics preferred.

For Details, write Mr. James Gilroy, Professional Placement Coordinator, Dept. 206B, Burroughs Corporation Research Center, Paoli, Pennsylvania.

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For Details write Mr. A. J. Bellace, Employment Supervisor, Burroughs Corporation Military Field Service Division, Dept. 206C, Burroughs Drive, Radnor, Pennsylvania.

MICHIGAN at our Burroughs Division in the Detroit Area

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Personnel Service, Inc.

(Continued from page 60A)

Electrical Engineer, Master's degree in electrical engineering, with experience in allied field desirable. Will study control requirements for thermo-electric systems; will also be involved with problems of transients, semi-conductors, circuitry and standard electrical studies and applications, i.e., electrical insulation, resistivity measurements and evaluation of electro-magnetic effects. Salary, $7500-$9000 a year. Location, New York State. W-7017.

Chief, Electrical Design Section, M.S.E.E., ten years' research and development, electronics instrumentation, computers, know computing techniques, ground and airborne instrumentation, weapons systems. Duties: Technical management of Electrical Design Section concerned with airborne and ground phases of electronic and/or electromechanical instrumentation. Position requires a high degree of ingenuity, imagination and versatility, some travel; car required. Salary, $9000-$10,000 a year. Location, north shore Chicago suburb. C-7195.

Electrical Design Engineer, B.S.E.E., with two to five years' experience in research and development computers, instrumentation, know electronics circuitry, transistors, computing techniques. Duties: Member of Electrical Design Section concerned with variety of electronics instrumentation programs. Position requires theoretical knowledge, some laboratory experience and versatility. Some travel; car required. Salary, $7000-$9000 a year. Location, north shore Chicago suburb. C-7196.

Designer, Development—Remote Control System, E.E. to M.S., with five years' electrical control application engineering experience; will design and assist in development of complete complex electromechanical remote control systems involving safe handling of isolated protective switchgear, motor switching, contractors, relays and direct, record actuate sensing-control devices (electrical, electronic, mechanical); for temperature, motion limits, pressure, flow on medium to heavy equipment (close tolerance actuators, drives and structures). For nuclear development. Salary commensurate with experience, to $9000 or more a year. Location, Oregon. S-3975.

Sales Engineer, Metal Equipment, E.E. background, with good electrical and mechanical sales experience in San Francisco area calling on engineers, architects, contractors and industries. Will handle line of cable trays, metal gratings, cabinets, fittings, hangers, power strut channel, brackets, racks, etc. Must know how to read electrical plans and should be able to take off and eventually figure square footage loads and prices. Operate from manufacturers' agent local warehouse and stock. Developed territory for long established company. Compensation commensurate with experience. Liberal incentive method—potential for $10,000 or better. Location, San Francisco Bay area. S-4013.

Electronic Engineer, Military, for man with specialized experience working with guided missile and fire control systems, including NIKE or HAWK systems. Duties: Assist consultant and professional electronics engineer for officers in charge of ordnance maintenance, supply; involves inspection, tests, operation, training and control of electronically controlled and free flight equipment. Some research and development. U. S. citizen. Salary, $8810 a year. Location, San Francisco, SG-4037.

Plant Engineer, Electrical, with professional license preferably, with a minimum of five years' high level professional experience in engineering department, plant and liaison with maintenance crews and contractors. Able to prepare plans for industrial wiring, including instrumentation and controls; organize and supervise multiplant operations under plant maintenance men; establish standards, select appropriate equipment, specify spare parts; must be familiar with NEC code relative to power,

(Continued on page 64A)

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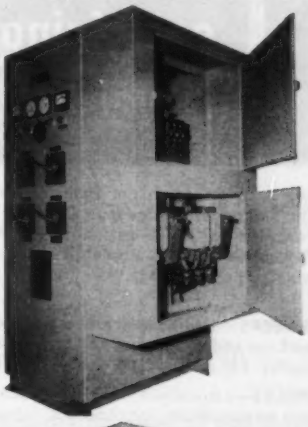

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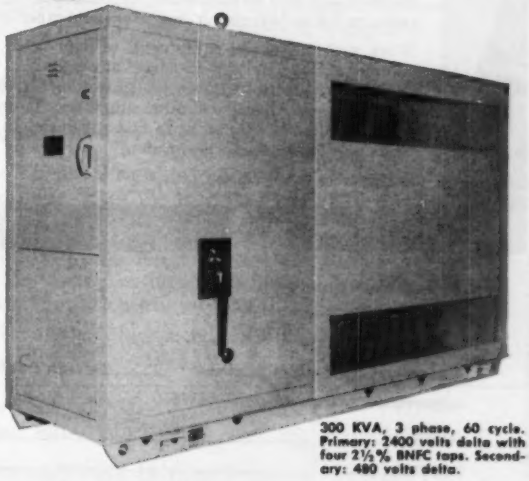
Primary: 480 volts with two 5% taps, 3 phase, 3 wire. Secondary: 105 volts to 140 volts (RC taps) and 140 volts to 350 volts (FC taps) in 7 volt steps; 2 phase, 4 wire.



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(Continued from page 62A)

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Designer, Industrial Electrical, E.E. plus California registration, to run electrical department in small consulting office, know electrical design, drafting, codes and requirements of refinery, chemical, process and industrial plants; able to handle own work and direct others for engineering consultant. Salary, to $9600 a year. Location, San Francisco. S-4086.

Test Engineer, Electrical Transformers, E.E. or equivalent, minimum of five years' experience testing (performance and production) Electrical power and distribution transformers to 75 KV and 5,000 KVA—full range of sizes and types; know standards, established tests for manufacturing quality control, operating performance and speciality requirements and able to operate impulse generator to one million volts; able to work directly under chief engineer and handle complete testing with little supervision. For manufacturer. Salary, $8100-$9300 a year. Location, San Francisco Peninsula. S-4088.

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on
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(April 1957)

The purpose of this 52-page bibliography is to provide an aid to the study of electrical phenomena in gases. There are well over 500 references and the arrangement is chronologically reversed in order to bring the most recent work forward. The order in each year's group is alphabetically arranged by first author.

Publication S-97 has been prepared for the Gaseous Dielectric Subcommittee under the sponsorship of the AIEE Committee on Dielectrics.

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(RED BOOK)

No. 952

The purpose of this publication is to bring to the attention of engineers, owners, and plant management the important features of well-designed electric distribution systems that result in satisfactory performance of utilization equipment and efficient operation of the plant; it covers the features of the electric distribution systems which are applicable to most types and sizes of industrial plants. It sets forth the elements of the distribution system both as to what to do to accomplish desired results and the reasons for them. It does not explain in detail how to accomplish the final results.

Basic information is included to determine the approximate load requirements of industrial plants, the type of distribution system, the distribution voltages, and voltage regulation, as well as information to assist the engineer in the selection of transformers, circuit breakers, relays, meters, fuses, cables, bus, and miscellaneous equipment needed in the design of an adequate electric distribution system for present and future load conditions. Operating and maintenance problems are dealt with only in so far as they affect system and equipment selection. Basic information is included to determine load requirements, type of system, and voltages. Data are included to assist selecting transformers, circuit breakers, relays, meters, fuses, conductor, and miscellaneous equipment for present and future loads.

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Companion Publication (Also October 1956)

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No. 953

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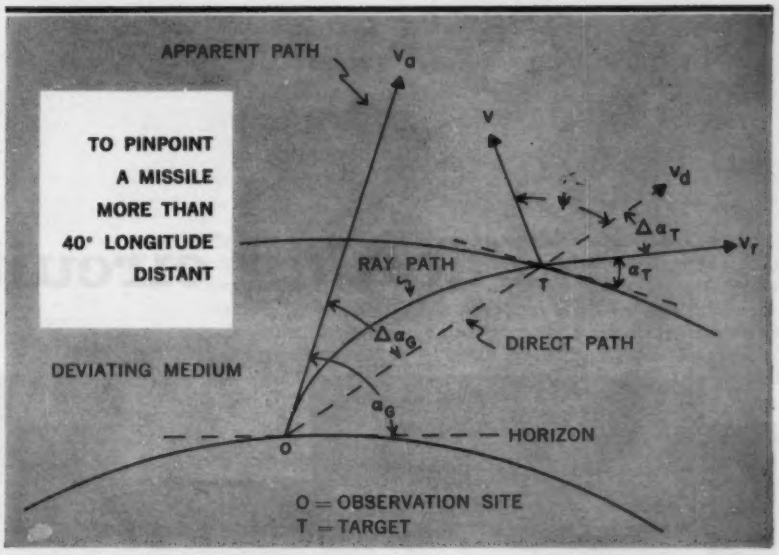

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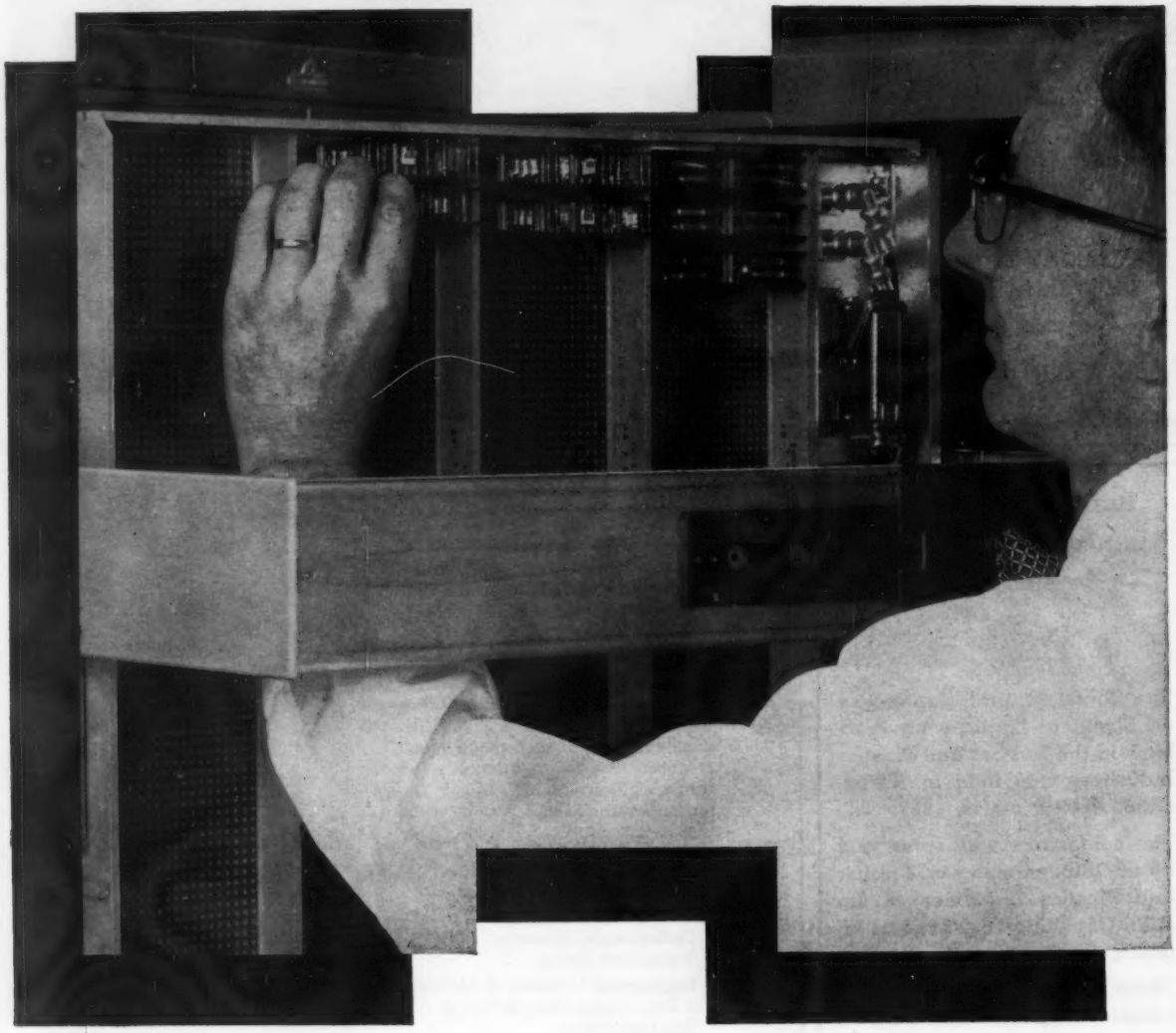

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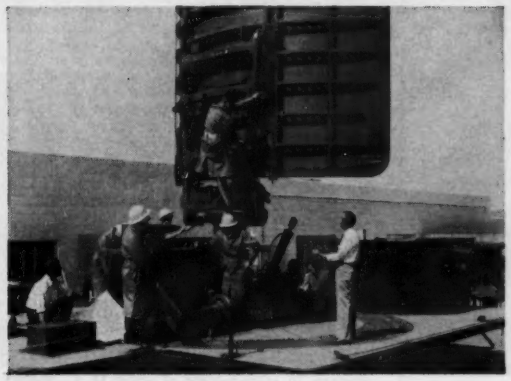
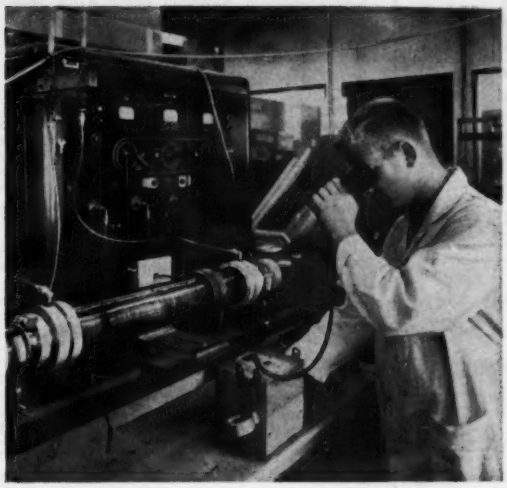


New Electronic Scanning radar antenna—Frescanar—developed by Hughes at Fullerton, positions beams in space by electronic rather than mechanical means.



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(Continued from page 53A)

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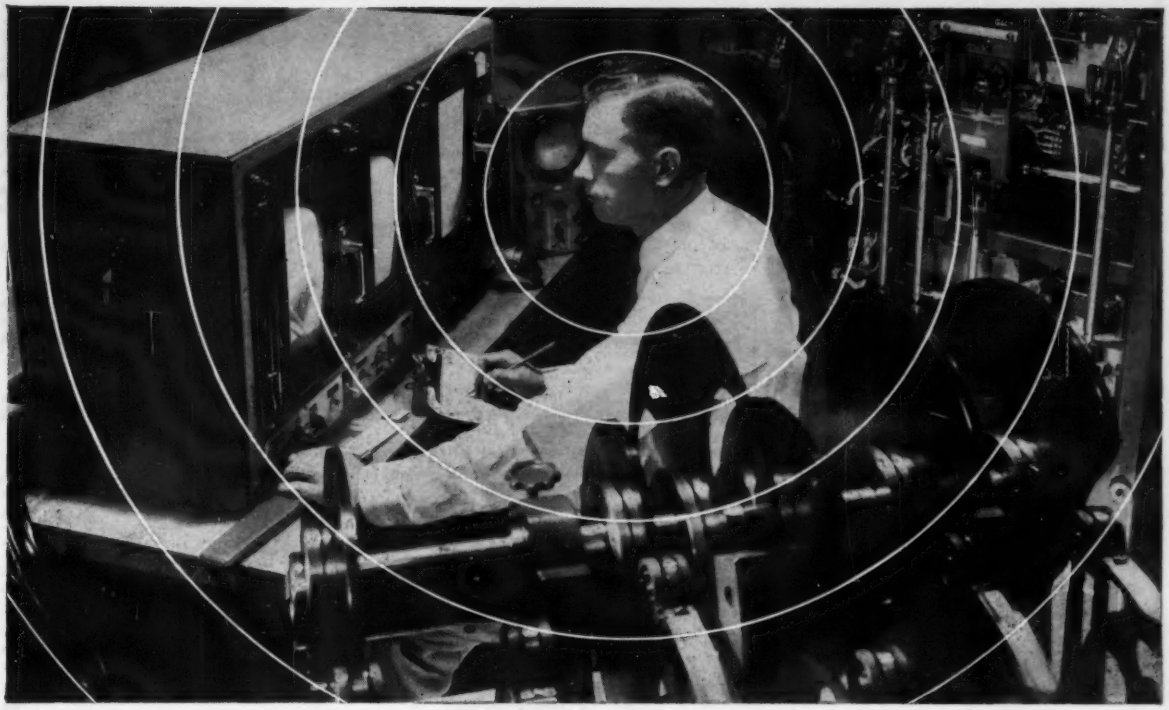

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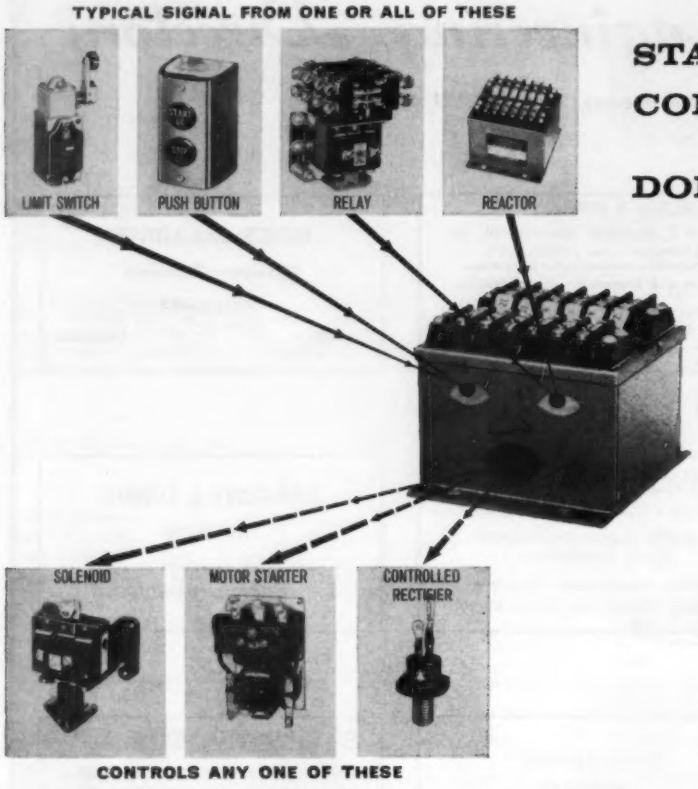

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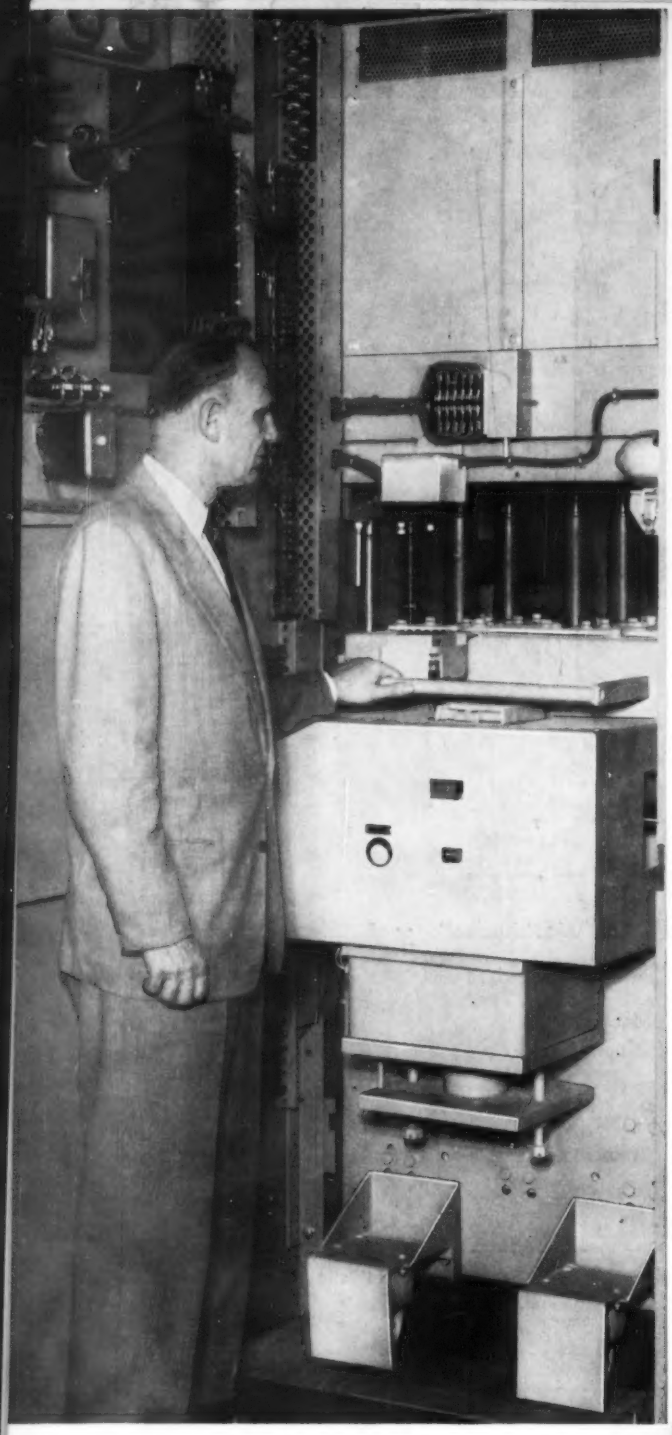

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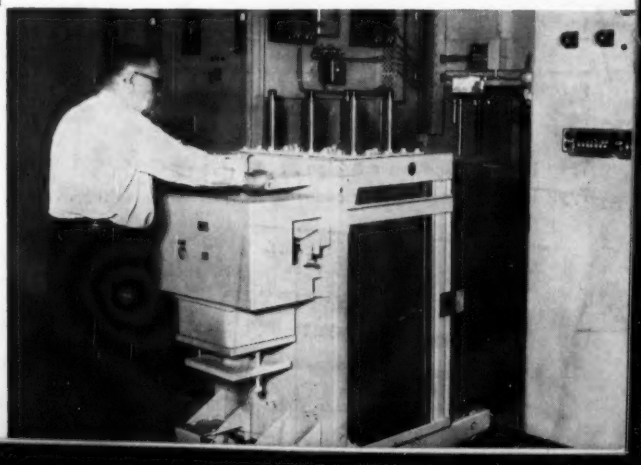

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